non | linear
systems, inc.

DEL MAR, CALIFORNIA

Instruction Manual

Series 125

AC to DC Converters

Standard Models:
125B, Part No. 18069
125C, Part No. 18072
125E, Part No. 18053

This manual is for instrument Serial No._____

NLS
Non-Linear Systems, Inc.
Del Mar, California

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INTRODUCTION

1.1 The Series 125

The NLS Series 125 AC to DC Converters allow NLS manufactured digital voltmeters to be used with alternating current input signals.

This input accessory is supplied in several versions so as to meet a number of user requirements. The basic instrument in the series is designated 125E; this accessory converter is designed to shift ranges automatically, manually, or remotely. The other converters in the series are designated 125B and 125C; these converters are manually ranged.

In addition, the basic 125E instrument is also available with other options; for example, the Model 125ER is equipped with a modified output so as to drive a reference input to the NLS 20 and 30 Series Digital Voltmeters for AC ratio use. There is also a Model 125ET automatic ranging instrument with built-in time delay. These latter two instruments, the 125ER and 125ET, are described in documents which, if needed, accompany this manual.

Since the basic instrument in the series is the 125E, the manual is primarily oriented toward the one instrument. The differences which exist among the three instruments are discussed in the remainder of this section. In addition, the parts list correctly identifies the components of each instrument in the series. Schematic diagrams of the 125B, 125C and 125E are at the end of the manual.

1.2 Model 125B (part number 18069)

The 125B is a simplified, manual-ranging version of the 125E and is suitable for use with any NLS digital voltmeter having a 10 megohm input impedance and a measuring range from 1 mv. to 9.999 volts. The following NLS digital voltmeters are compatible with the 125B:

V64A 481A 484 V35 V35A V34 V34A	All use converter output cable 15004-129 and DC input cable 15004-126.
M24	Uses 15004-128 input cable and 15004-075 output cable.

The 125B specifications are the same as for the 125E as listed in Section 2 of this manual. However, neither automatic ranging nor remote operation are provided. Since the 125B is manually ranged, a front-panel multiplier switch is used for range selection. The instrument will operate at maximum accuracy in its 10-volt (9.999) range. If the digital voltmeter used with the converter has a manual DC range switch, it should be locked in the 10-volt position; the AC position is used on digital voltmeters so equipped. In any case, the output of the converter should not be allowed to exceed 9.999 volts; this can be controlled by manipulating the converter front-panel switch. The remaining sections of this manual are wholly applicable except as noted in this section.

1.3 Model 125C (part number 18072)

The 125C is a remotely ranged version of the 125E Converter and is compatible with any NLS digital voltmeter having a 10-megohm input impedance and a measuring range from 1 mv. to 9.999 volts. Thus, the 125C may be used with NLS Models V35, V35A, V34, V34A, and M24. The cabling connections are made with the same cables listed for the Model 125B (Section 1.2) except that an added interconnecting cable, 15004-076, is needed to provide digital-voltmeter-switched power and remote ranging connections.

The 125C Converter will lock to the range set on the associated digital voltmeter. However, maximum accuracy is obtained by operating the digital voltmeter in its 10-volt (9.999) range. The AC setting on the digital voltmeter is used for all AC readings. To avoid exceeding the 9.999-volt limit of the converter, attenuators are provided which are controlled by the digital voltmeter RANGE switch. In this way, it is possible to read up to 1000 volts.

The NLS Engineering Department will be glad to help you with specific application problems. A call or letter to our office in your area, as listed in the *Appendix*, or to the home office, will receive prompt attention.

SPECIFICATIONS

Input Voltage Ranges:

10/100/1000 volts AC. These ranges are selected:

1. Automatically,
2. Manually, by a switch on the digital voltmeter, or
3. Remotely, through contact closures.

Input Impedance:

10 megohms and 40 uuf shunt capacitance.

Output Voltage:

10 volts DC for 10, 100, or 1000 volts AC input (governed by the input voltage range in use) when connected to the 10-megohm input load of an NLS digital voltmeter.

Compatibility with NLS Digital Voltmeters:

The 125E Converter may be connected without wiring changes to the NLS Models V34A, V35A. The converter is also compatible with the Models V24 and M24 having serial number 10.700 or larger.
If the 125E is to be used with other instruments, or with earlier versions of the M24 and V24, consult an NLS representative or the factory for wiring changes.

Frequency Range:

30 cps to 10 kilocycles.

Accuracy of AC-to-DC Conversion (% of Full Scale on Each Range):

0.1% of reading, plus one digit.

Calibration:

The 125E is calibrated in terms of the RMS value of a pure sine wave. The converter output voltage is proportional to the average value of the input voltage.

Balancing Time:

3 seconds, average.

Connections:

Signal input and signal output grounds are common, but are not connected directly to the converter's chassis within the converter. The converter's chassis and digital voltmeter chassis are common when the two instruments are connected. Type MS3102A connectors on the rear panel are used – one each for the input and output.

Power Source:

115 VAC, 60 cycles; power consumption is 70 watts. No power cord is used; the 125E converter draws its power through cabling to the digital voltmeter. The digital voltmeter power switch is wired ahead of the converter power take-off so that the converter works in unison with the digital voltmeter.

Dimensions:

The 125E mounts in a standard 19" wide rack, is 3½" high and 15¼" deep.

Weight:

Net: 27 lbs., shipping: 45 lbs.

NOTE

Except as noted in the Introduction, the above specifications are applicable to the 125B and 125C Converters.

INSTALLATION AND OPERATION

3.1 Operating Environment

The 125E Converter may be mounted in a rack with associated equipment or it may be used as a bench instrument. Care should be taken to assure proper ventilation. Allow space for the blower exhaust at the rear as well as at the sides for air intake. Operation near strong electrical fields, as occur at radio transmitters and other radio-frequency equipment, should be avoided unless elaborate steps for electrical shielding have been taken. Stray high-frequency signals can be a source of spurious readings on the digital voltmeter. Since the converter uses mercury-wetted relays, it should not be tilted more than 30 degrees from the horizontal. Environmental conditions which are suitable for a digital voltmeter will suffice for the 125E Converter.

3.2 Connection Procedures

1. Connect the 34-pin connector (J-13) on the converter to the AC converter connector on the rear panel of the DC digital voltmeter by using the cable furnished with the converter. Figure 3-1 shows typical cables and Figure 3-2 identifies cabling connections.

2. Connect the converter's DC output (connector J-12) to the input terminal of the DC digital voltmeter by using the harness furnished with the converter. With Series 20 digital voltmeters, cable 15004-128 is used; with Series 30 instruments, the 15004-129 cable is used.

3. Connect the AC or DC input signal to J-11 at the rear of the converter. See Figure 3-3.

Pin A	Input high side
Pin B	Input low side
Pin C	Carries chassis ground of digital voltmeter and converter through converter to input.

NOTE

When measuring AC voltages, Pins B and C should normally be shorted together. If any AC voltage exists between Pins B and C, converter accuracy will suffer.

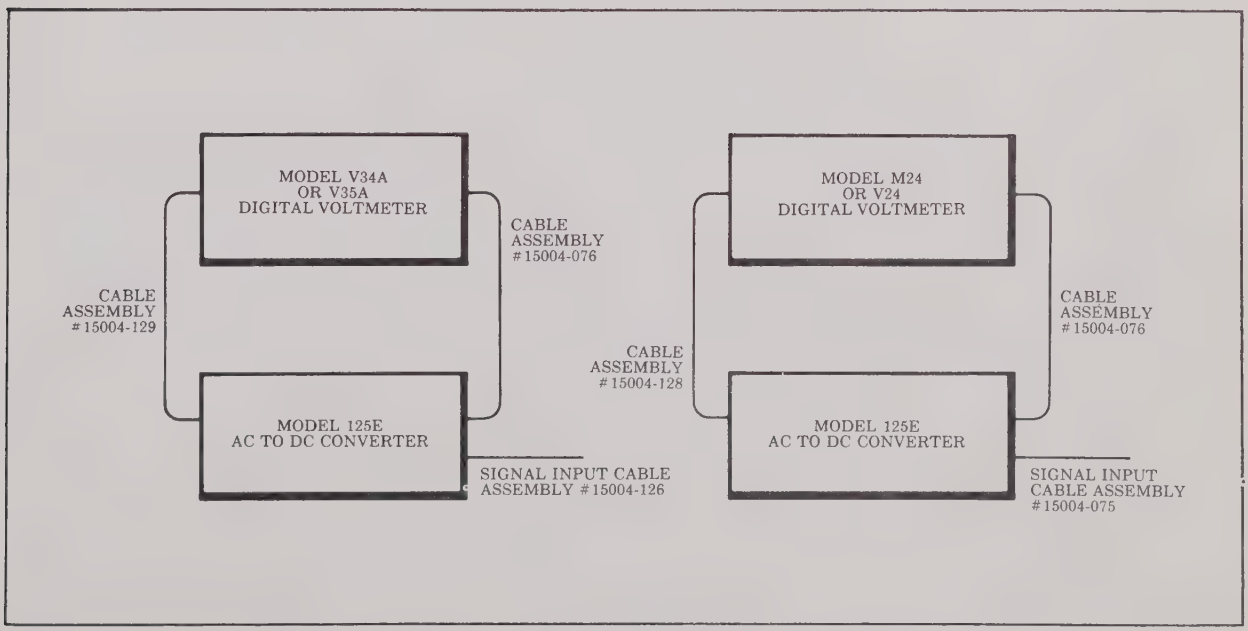


Figure 3-1. Cables Supplied with Converter.

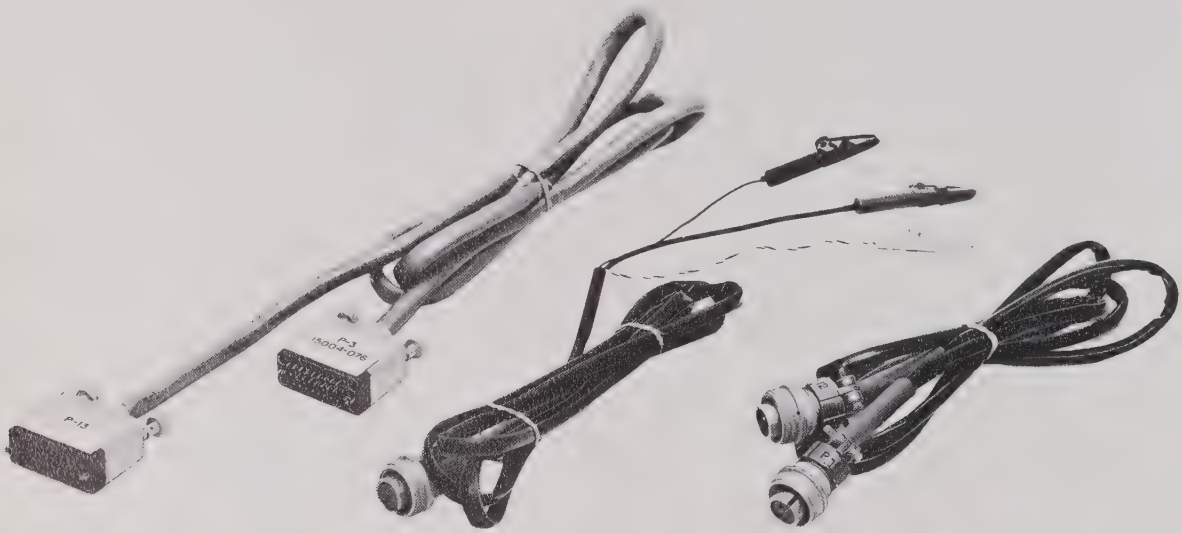


Figure 3-2. Cable Assemblies by Part Number.

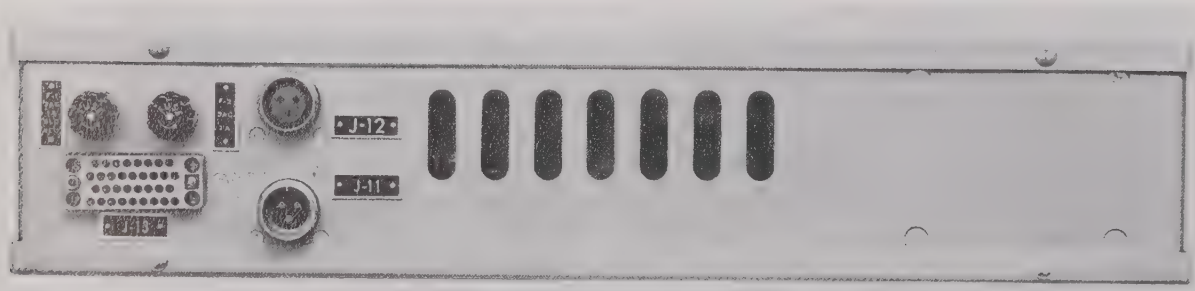


Figure 3-3. Converter, Rear View.

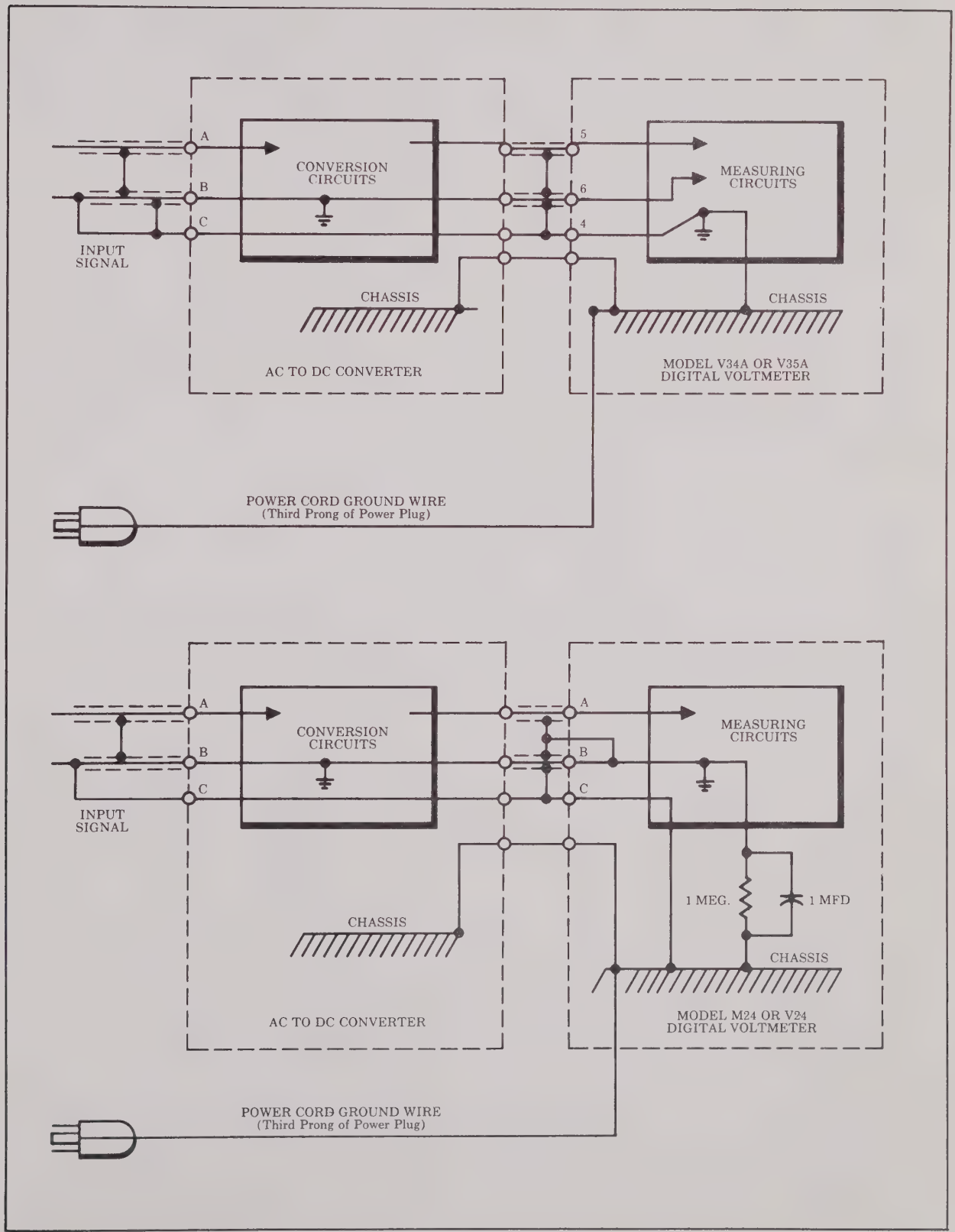


Figure 3-4. Ground Circuits.

On AC ranges, the digital voltmeter's selector switch connects the input signal to the AC-DC conversion circuits. On DC ranges, the selector switch connects the input signal directly to the converter's DC output (connector J-12). Remember that test lead capacitance can cause appreciable loading of signal circuits, especially at high frequencies. See Figure 3-4.

CAUTION

Chassis ground and signal ground are not connected together in the converter, but they are connected together through the digital voltmeter. Fuse F-2 protects the wiring against burnout if a "hot" lead is connected to the signal ground terminal.

Where completely ground isolated AC signal connections are required, use an external input transformer for the signal circuits. Important factors in transformer selection include frequency response characteristics, primary impedance, turns ratio accuracy, and adequate shielding to prevent noise pickup. Primary impedance is important only because of the effect that a low primary impedance might have upon the output voltage of the circuits being measured. Frequency response characteristics and turns ratio accuracy are important because of the effect they have on overall measurement accuracy.

4. Set the range selector switch on the digital voltmeter's front panel to AUTO VAC on the range of expected use for AC signals or to the DC position when measuring DC signals.

5. Turn on the 115-volt AC power.

6. The digital voltmeter readout decimal point location is controlled by the range selector switch or by the automatic range selection circuitry in the converter.

7. For remote selection of AC voltage range and AC or DC measurements, refer to the drawings provided with the digital voltmeter associated with the converter.

CAUTION

Do not connect more than 1000 volts to the converter input. Full accuracy is only obtained with inputs no higher than 10 volts on the 10 volt range, 100 volts on the 100 volt range, and 1000 volts on the 1000 volt range.

CALIBRATION

4.1 General Procedure

To calibrate the converter, connect the equipment as shown in Figure 4-1; sweep the AC voltage source over the converter's frequency and voltage range or over the range required in your application, and compare the digital voltmeter's readings to readings on the standard AC voltage measuring instrument. The two sets of readings should agree after the composite error of several factors has been weighed. Consider the following possible errors:

1. Total error of the converter,
2. Error of the DC digital voltmeter,
3. Error of the standard AC voltage measuring instrument, and
4. Error due to harmonic distortion in the AC voltage source.

If, after considering the areas in which error may occur, the converter is not within tolerance, follow the balance of this section to readjust the instrument.

4.2 Precautions

Before calibrating, observe the following:

1. Load the converter's output only with a digital voltmeter having a 10-megohm input impedance. The converter has a high output impedance and small changes in load can affect its DC voltage output appreciably.

2. Calibration signal source must be very stable.

3. The calibration signal source wave form must be sinusoidal with low harmonic content to minimize inaccuracies caused by harmonic distortion. Remember, the converter is designed for measuring sinusoidal voltages; its reading is proportional to the average value of the input wave form and the instrument is calibrated at the factory to indicate the RMS value of a pure sine wave. If the signal wave form is not a pure sinusoid, do not expect the converter to agree with an AC instrument which measures the wave-form RMS value (thermal converters, dynamometer-type voltmeters, etc.). Differences between AC measurements made with the converter and the true RMS values of non-sinusoidal wave forms depend upon relative magnitudes and phase relationships between the fundamental and the harmonics which are present.

The following table shows the maximum differences that can exist between the measurements made with the average sensing converter and the true RMS value of the wave form being measured. Actual differences may be much less than the maximum shown in the table depending upon phase relationships between fundamental and existing harmonics.

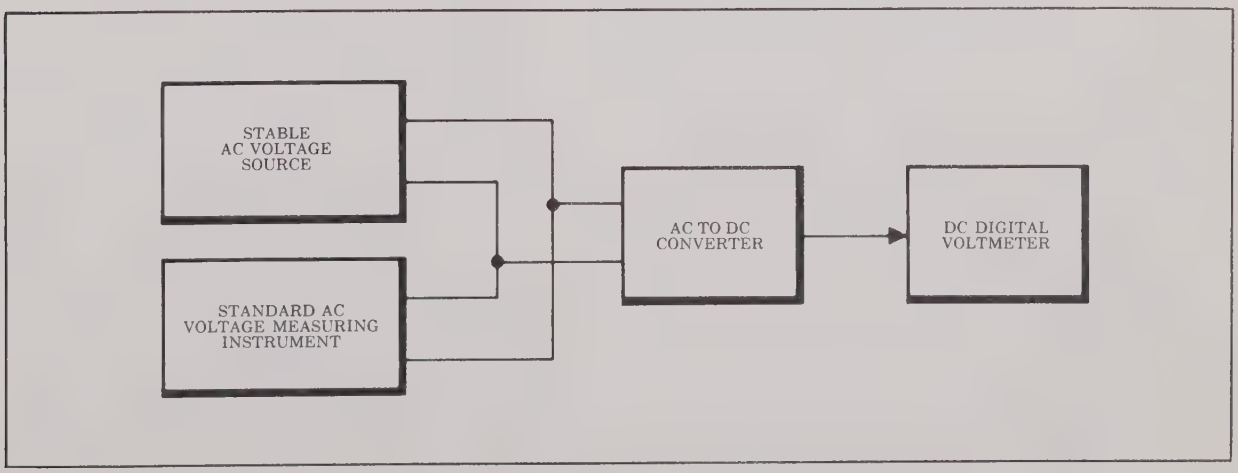


Figure 4-1. Flow Diagram for Calibration Setup.

Second Harmonic	
Percent Harmonic	Maximum Error Expected
10%	0.5%
20%	2 %
50%	12 %

Third Harmonic	
0.3%	0.1 %
0.5%	0.17%
1 %	0.35%
5 %	1.7 %
10 %	4.5 %
20 %	8 %
50 %	22 %

4. Before calibrating the converter, the associated DC digital voltmeter must be within its specified accuracy tolerance.

5. Use shielded leads and a good ground to prevent noise pick-up problems.

6. One input terminal of the converter is connected to the digital voltmeter chassis, except in Series 20 instruments carrying part numbers below 10.700. Do not apply a potential between the "low" signal input terminal and chassis. A fuse has been provided to prevent damage to the wiring if this sort of connection is attempted.

7. For the best results, permit the converter to warm up for thirty minutes before adjusting its calibration controls.

8. Any voltage dividers used in the calibration procedure must be frequency compensated. At high frequencies, test wiring capacitances and converter input capacitance can cause appreciable loading; therefore, test leads should be as short as possible.

9. As with most measuring instruments, calibration is more accurate when performed near the top of each voltage range.

10. The adjustment procedure in Section 4.3 mentions frequencies of "30 to 100 cps" and "10 kc." Other frequencies between 30 cps and 10 kc can be used if these frequencies are not available. For example, 400 cps can be used for low frequency adjustments and 5 kc may be used for high frequency adjustments; the possibility of error below 400 cps and above 5 kc must be accepted. If your application requires use at a single frequency, maximum accuracy will be obtained if calibration is made at that one frequency.

11. The time required for calibration will be much shorter if the readings obtained after each step given in Section 4.3 are plotted on graph paper. Then, the effect of each control will be readily apparent. After reviewing the graph, the controls can be more satisfactorily adjusted to bring the converter into tolerance by, for example, causing an intentional error in one direction at a certain frequency so as to cause the curve of frequency versus error to come within tolerance at other frequencies. Another reason why the plotted readings are helpful is that frequency compensation controls have a much greater effect at higher frequencies than at lower frequencies. Figure 4-2 plots error versus frequency for a typical converter after calibration.

12. During the calibration procedure, the top and bottom covers of the converter should be in place. However, the front panel is removed to provide access to these controls. The front panel may be removed by detaching the handles. Adjustment controls are labeled on the inside panel as shown in Figure 4-3.

4.3 Adjustment Procedure

In the procedure steps which follow, the phrases "for agreement" or "to achieve agreement" mean *to bring the digital voltmeter reading within the accuracy tolerance required.*

1. Switch the digital voltmeter to bring the converter to the 10-volt range.

2. With an input voltage slightly less than 10 volts, at a frequency between 30 and 100 cps, adjust R-2 (labeled LOW FREQUENCY ADJUSTMENT, 10 V) for agreement.

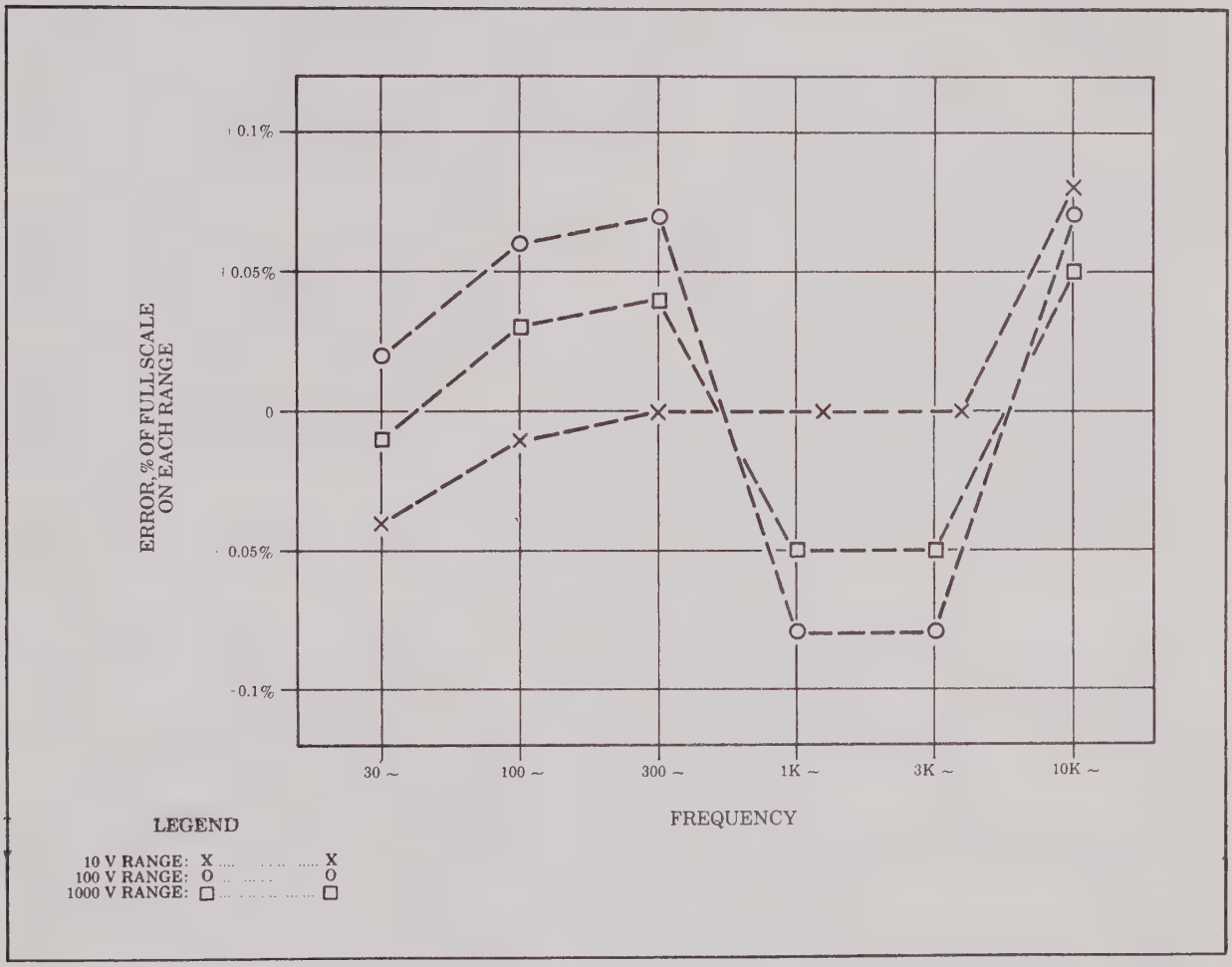


Figure 4-2. Typical Plot of Error vs Frequency after Calibration.

3. Switch the digital voltmeter to bring the converter to the 100-volt range.

4. With an input slightly less than 100 volts at a frequency between 30 and 100 cps, adjust R-3 (labeled LOW FREQUENCY ADJUSTMENT, 100 V) for agreement.

5. With an input voltage slightly less than 100 volts, and at a frequency of 10 kc, adjust C-1 (HIGH FREQUENCY ADJUSTMENT, 100 V) for agreement.

6. Repeat Step 4 and readjust R-3 (LOW FREQUENCY ADJUSTMENT, 100 V) if needed to achieve agreement. If R-3 has required readjustment, repeat Step 5. It may be necessary to repeat Steps 4 and 5 several times to achieve agreement at low and high frequencies. The adjustment of R-3 and C-1 can be readily achieved if it is realized that R-3 affects both the low and high frequency calibration, while C-1 affects mostly the high frequency calibration.

7. With an input voltage of at least several hundred volts and at a frequency of between 30 and 100 cps, adjust R-4 (LOW FREQUENCY ADJUSTMENT, 1000 V) for agreement.

8. With an input voltage of several hundred volts at 10 kc, adjust C-2 (HIGH FREQUENCY ADJUSTMENT, 1000 V) for agreement.

9. Repeat Step 7 and readjust R-4 (LOW FREQUENCY ADJUSTMENT, 100 V) if needed to achieve agreement. If R-4 requires readjustment, repeat Step 8. It may be necessary to repeat Steps 7 and 8 several times to achieve agreement at low and high frequencies. The adjustment of R-4 and C-2 can be achieved more readily if it is recognized that R-4 affects both the low and high frequency calibration while C-2 affects mostly the high frequency calibration.

10. C-1 and C-2 slightly interact if either one requires a large change during calibration. Repeat Steps 4 and 5 to check interaction. All ranges of the instrument are now in calibration. The remaining steps in the adjustment procedure apply to the automatic range changing circuitry only.

11. Rotate R-5 and R-6 counterclockwise and R-7 and R-8 clockwise until their stops are reached.

NOTE

The potentiometers require 43 turns to travel from stop to stop.

12. Apply 9.40 V of any frequency from 30 cps to 10,000 cps to the input of the converter.

13. Switch the digital voltmeter to bring the converter to the AUTO VAC mode. The digital voltmeter should read 09.40 V.

14. Rotate R-5 clockwise until the converter down ranges. The reading will then be 9.400 ±0.010.

15. With 94.0 volts going into the converter, the digital voltmeter should read 09.40 V.

16. Rotate R-6 clockwise until the converter down ranges. The reading will then be 94.00 ±00.10.

17. With 9.900 volts going into the converter, the digital voltmeter should read 9.900 V.

18. Rotate R-7 counterclockwise until the converter up ranges. The reading will then be 09.90 ±00.1 V.

19. With 99.00 volts going into the converter, the digital voltmeter should read 099.0 ±000.1 V. The converter has now been completely calibrated.

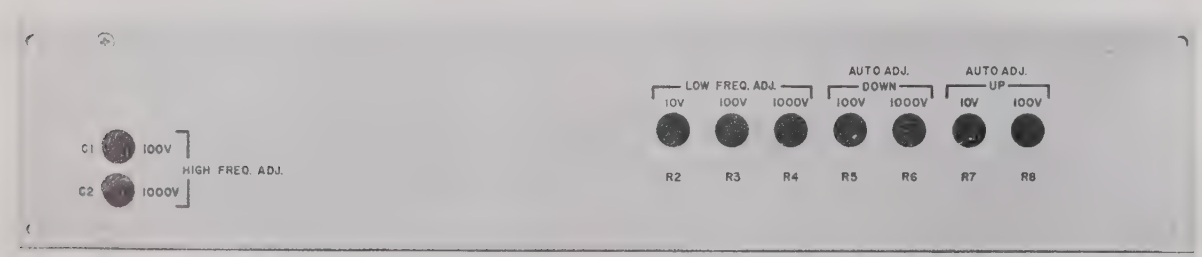


Figure 4-3. Location of Calibration Controls made Accessible by Removal of Front Panel.

THEORY OF OPERATION

In the Model 125E Converter, semi-conductor diodes are used to convert the unknown AC input into pulsating DC. This DC is then filtered to obtain a very pure DC voltage proportional to the average value of the AC input wave form. A high-gain feedback system linearizes and stabilizes the rectification characteristics of the diodes. To best understand the operation of the Model 125E Converter, Figure 5-1, Signal Flow Diagram, and the main foldout schematic at the rear of the manual should be consulted.

The converter input attenuator (range unit) attenuates the unknown AC input by precisely 10:1 or 100:1, as required to restrict the conversion circuit input to 10 volts, maximum, for full scale inputs of 100 volts and 1000 volts, respectively. C-1 and C-2 provide frequency compensation adjustment in the attenuator on the 100-volt and 1000-volt ranges, respectively.

The attenuator output is fed into a high-input impedance-isolation amplifier, V-2A, and

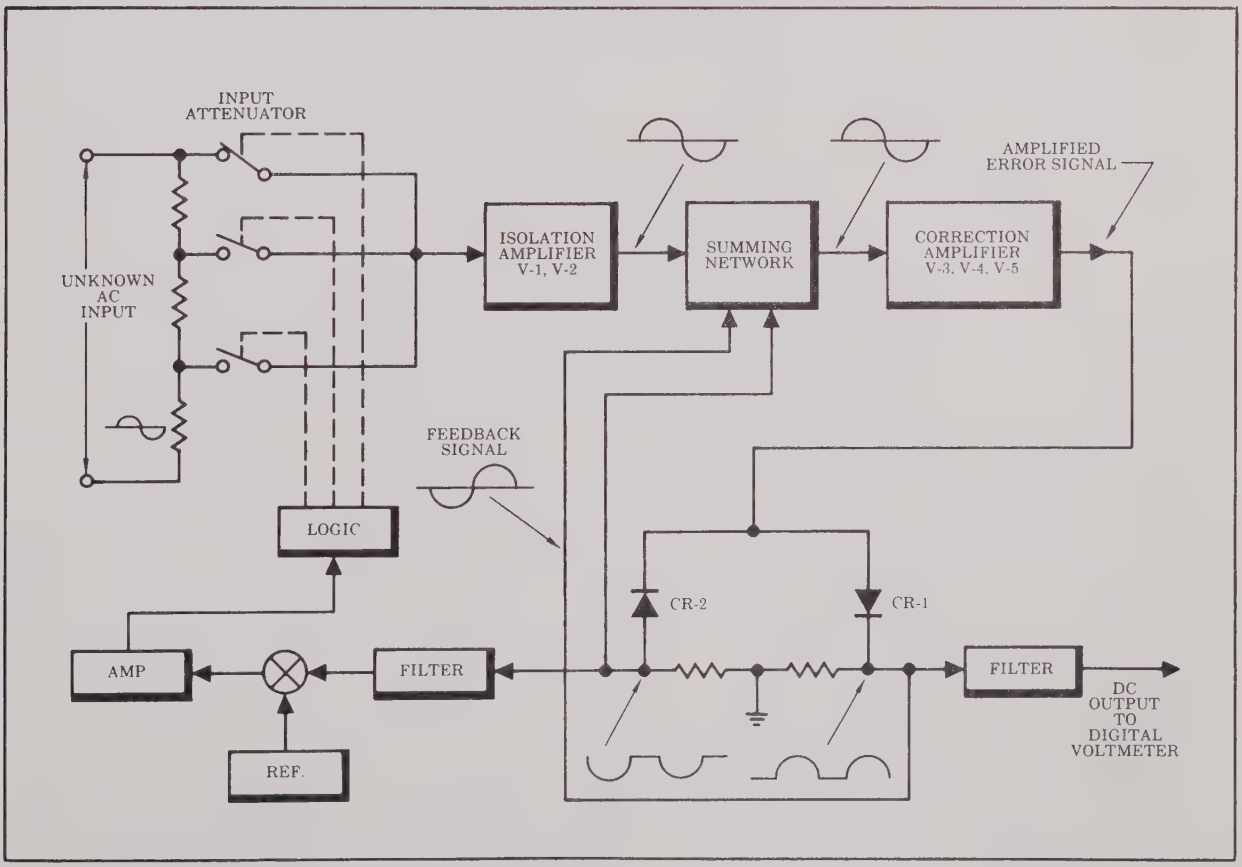


Figure 5-1. Signal Flow Diagram.

V-2B, which prevents the summing network R-18, R-19, R-20, R-21, and C-15 from loading the input attenuator.

The summing network sums the isolation amplifier output with a 180° out-of-phase feedback voltage derived from the converter output stage. The summing network output is amplified by the high gain amplifier V-6, V-7, and V-8, and rectified by diodes CR-13 and CR-14. The half-wave output of CR-13 is filtered and forms the DC output of the converter. The feedback signal is obtained by mixing the half-wave outputs of CR-13 and CR-14. R-2, R-3, and R-138 form adjustable output voltage dividers which permit adjusting the scale factor on each range. Relays K-1 and K-2 operate when selecting a mode of operation (AC measurements or DC measurements); K-3, K-4, K-5, and K-6 operate when selecting the AC voltage range. An internal 28-volt DC supply furnishes power for relays in the converter.

The output of the second filter operating from a half-wave output of CR-14 is compared with a DC reference by chopper K-7 and amplifier Q-3. The output of Q-3 controls the transistor logic circuits. The output of the logic circuit is allowed to control range relays K-3, K-4, K-5, and K-6 when the converter is operating in the automatic mode.

Section 6

MAINTENANCE AND TROUBLESHOOTING

Trouble-shooting is much easier once the user has become completely familiar with the operation and theory of the instrument as described elsewhere in this manual.

The first general step in correcting any trouble which may develop in the converter is to isolate the malfunctioning section or sections of the circuit. The trouble-shooting tables and tube socket voltage charts at the end of this section will help to localize the area of breakdown. In addition, systematic signal tracing can locate troubles not mentioned in the charts. Additional maintenance help is available through the N.L.S. representative in your area, or directly from the home office of Non-Linear Systems, Inc.

6.1 Test Equipment

The only test equipment required for maintenance of the converter are an oscillator, a vacuum tube voltmeter, and an oscilloscope. Special equipment needed for calibrating the converter is discussed elsewhere in the manual.

6.2 Spare Parts

Most electronic parts used in the converter are standard, commercially available items. A parts list along with a separate spare parts list is included in this manual. If unlisted mechanical parts are needed, contact the home office of Non-Linear Systems, Inc., or a regional sales and service representative.

6.3 Signal Tracing

This section gives information to aid in tracing signals through the converter. Refer to Figure 5-1, Signal Flow Diagram, and the converter's schematic for additional information. Most voltage measurements are made with respect to signal ground.

1. Setup:

Connect a stable AC voltage to the converter's input terminals. Follow the instructions given in Section 3, Installation and Operation. The AC voltage should be slightly under 10 volts to avoid saturation, unless trouble is evidenced on the higher ranges.

2. Input attenuator:

The input attenuator output can be measured at Pin 2 of V-2. However, loading effects present so great a problem that measuring the attenuator's output voltage is generally of little help in trouble shooting.

CAUTION

Do not bend the wires which interconnect the range attenuator components. Attenuator wiring capacitances are very critical and the calibration will be affected by capacitance changes.

3. Isolation amplifier:

The output of the converter's isolation amplifier is measured at Pin 3 of V-2. As an accurate unity gain amplifier, its output voltage should be equal to its input voltage to within 0.2%. If it will help isolate trouble, disconnect the unity gain amplifier and drive the remainder of the converter from an AC signal source. This disconnection may be made by simply unsoldering the lead which connects C-15 to Pin 3 of V-2. Connect the AC input signal to the unsoldered end of C-15.

4. Correction Amplifier:

The correction amplifier is best tested by measuring the error signal at Pin 1 of V-7. The error voltage is normally 40 millivolts, maximum. A large error signal usually indicates absence of feedback voltage. Feedback voltage is developed by the correction amplifier output at Pin 7 of V-6, then through C-26, CR-13, CR-14,

R-20, and R-21. The summing network, which consists of R-18 and R-19, sums the isolation amplifier output and CR-13 and CR-14 output to form an input (error signal) for the correction amplifier.

5. Conversion Diodes:

When a 10-volt RMS sine wave is applied to the converter's input terminals, the voltage from the junction of CR-13 and R-20 to ground and the voltage from the junction of CR-14 and R-21 to ground should be approximately 22 volts, peak. The wave form at each of these junctions should be a half-wave rectified sine wave. Use a low capacitance probe when measuring CR-13 and CR-14 output.

6. Output Filter:

The output filter (R-22, R-23, R-24, C-9, and C-15, and C-16) filters the half-wave output

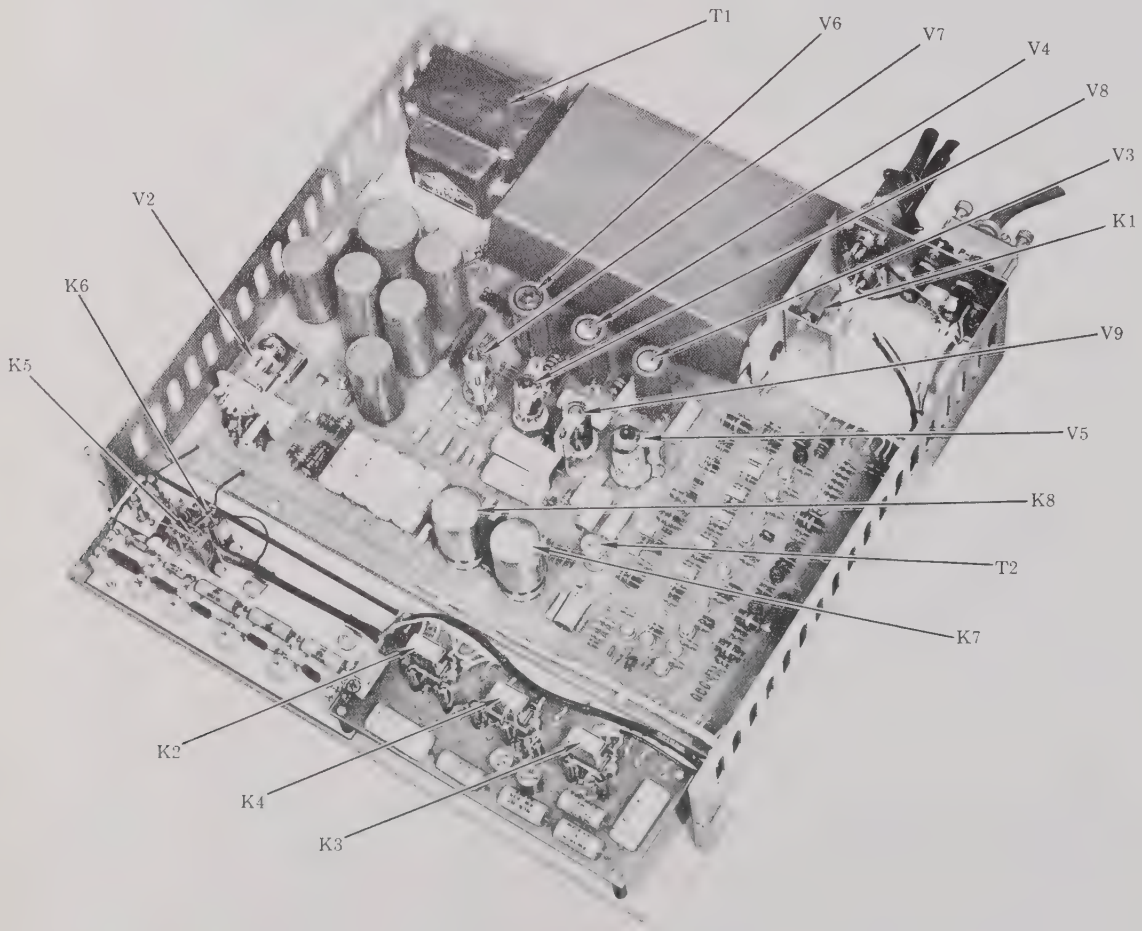


Figure 6-1. Top View of Converter with Front Panel Dropped to Reveal Ranging Components.

of CR-13 to form the pure positive DC output signal. The filter's time constant is relatively long since it must reduce the ripple in the converter output to less than 0.01% even with AC outputs as low as 30 cps, and CR-13 output contains a large AC component. Because of the high series resistance of the output filter, the converter's output voltage will be greatly affected by the load connected to the converter output terminals. The converter's output voltage is correct only when its load is an NLS digital voltmeter with 10 megohms impedance.

7. Auto Range Filter:

This circuit (R-36, R-37, R-38, C-19, C-27, and C-28) filters the output of CR-14 to form a pure negative DC output signal; the time constants are the same as described in the preceding paragraph.

8. Auto Range Reference:

The output of the auto range filter is continuously summed through R-64 and R-68 with reference voltages coming from the reference attenuator (R-5, R-6, R-7, R-8, R-60, and R-61). The attenuator is supplied voltage by the +280-volt regulated power supply.

9. Chopper and Amplifier:

A line synchronous chopper (K-7) driven by Q-2 converts the voltage at the junction of R-64 and R-68 into pulses. The amplitude and polarity of these pulses vary linearly with the difference between the auto range filter voltage and the auto range reference voltage. The pulse amplifier, Q-3 and T-2, amplifies these pulses sufficiently to trigger the UP and DOWN flip-flops.

10. UP and DOWN Flip-Flops:

The flip-flops are triggered by the amplifier and are reset by the chopper driver, Q-2. The state of these flip-flops determines the state of the UP and DOWN pulse lines which control the state of A and B flip-flops.

11. A and B Flip-Flops:

These flip-flops control the 10 V, 100 V, and 1000 V buffers in the automatic mode. Refer to the chart on the main schematic to see the relationships between the UP and DOWN flip-flops, and the A and B flip-flops.

12. Buffers:

The 10 V, 100 V, and 1000 V buffers (Q-4, Q-5, and Q-6) control the range relays (K-3, K-4, K-5, and K-6). They also control the range indicators in the digital voltmeter readout by way of Pins H, K, and J of J-13.

6.4 Tube Socket Voltages

Knowledge of these voltages will be useful for trouble-shooting purposes. Measurements are made with respect to signal ground rather than to chassis ground. Generally, considerable voltage variation can be tolerated. These measurements are made with a line voltage of 115 volts. "FIL" means Filament. In some cases, filaments are operating above ground. Refer to the main foldout schematic at the rear of the manual for filament wiring.

TUBE SOCKET VOLTAGES

Measured with 10 Megohm Input VTVM (HP 410B)

	SOCKET PIN								
TUBE	1	2	3	4	5	6	7	8	9
V-2	150	25	27	Fil	Fil	278	—	150	Fil
V-7	—	1.38	Fil	Fil	278	59	1.38	—	—
V-8	—	1.38	Fil	Fil	137	59	1.38	—	—
V-6	2.6	1	2.6	Fil	Fil	Fil	155	135	2.6
V-3	255	278	Fil	Fil	520	520	255	—	—
V-4	255	278	Fil	Fil	520	520	255	—	—
V-5	258	170	170	Fil	Fil	170	84	85	Fil
V-9	85	—	—	—	85	—	—	—	—

Measured with 20,000 Ohms/Volt Voltmeter

	SOCKET PIN								
TUBE	1	2	3	4	5	6	7	8	9
V-2	150	—	27	Fil	Fil	278	—	150	Fil
V-7	—	1.35	Fil	Fil	275	54	1.35	—	—
V-8	—	1.35	Fil	Fil	135	54	1.35	—	—
V-6	2.5	—	2.5	Fil	Fil	Fil	150	130	2.5
V-3	250	275	Fil	Fil	520	520	250	—	—
V-4	250	275	Fil	Fil	520	520	250	—	—
V-5	258	170	170	Fil	Fil	170	83	84	Fil
V-9	84	—	—	—	84	—	—	—	—

TROUBLESHOOTING CHART

SYMPTOM	PROBABLE CAUSE	REMEDY
Converter output voltage high (about 24 volts) for any value of input signal.	Feedback voltage is not reaching correction amplifier.	Correct the open circuit or faulty component between conversion diodes and correction amplifier input.
Converter output voltage very low on 100 or 1000 volt ranges.	Range selector switch is on wrong range.	Select proper range.
	Open circuit or faulty resistor in input attenuator.	Replace faulty component.
	Faulty range relay K-3, K-4, K-5, or K-6.	Replace faulty relay.
Converter output exceeds several millivolts with input leads grounded.	Excessive hum pick-up from heater to cathode leakage in some vacuum tube.	Replace faulty vacuum tube.
Converter output zero, or very low and continuously drifting.	Ground fuse, F-2, blown.	Replace fuse. Do not connect "hot" lead to signal "low" side terminal.
	Relays K-1 or K-2 faulty.	Replace faulty relay.
	Faulty vacuum tube.	Replace tubes.
Converter output voltage zero on any one range.	Range calibration pots R-2, R-3, or R-4 open circuited. Range relays K-3 or K-4 faulty.	Replace faulty components.
Converter output much too high on all ranges at all frequencies.	R-138 open circuited.	Replace faulty component.
Converter output continuously drifts.	Low B+ voltage.	Repair power supply or remove excessive load from power supply.
Tube filaments do not light and blower does not operate.	Power fuse, F-1, blown.	Replace fuse. Examine circuits for excessive loads.
When measuring high frequency signals, converter can be almost, but not completely, brought into tolerance.	CR-13 and CR-14 faulty.	Replace.
	Low frequency calibration controls must be readjusted sufficiently to permit bringing calibration in at high frequencies.	Recalibrate entire converter. See calibration procedure.
Converter output very non-linear as a function of input frequency.	Conversion diodes CR-13 or CR-14 are bad.	Replace faulty diodes.
Converter cannot be brought into tolerance on 100 or 1000 volt ranges when measuring low and high frequency signals.	V-1 drawing excessive grid current.	Replace V-1.
Digital voltmeter connected to converter will not measure DC voltages.	K-1 or K-2 faulty.	Replace K-1 or K-2.
Entire AC input signal appears at converter output.	K-1 faulty.	Replace K-1.
Converter will not automatically change range.	Faulty chopper.	Replace K-7.
Readout shows an extra decimal.	Shorted Buffer (Q-4, Q-5, or Q-6).	Replace transistor.

RECOMMENDED SPARE PARTS LIST

This section lists the spare parts which we recommend be stocked for the maintenance of ten (10) Model 125E Converters for a period of one year. If you desire to know the name of the manufacturer, check this list against the parts list given in Section 8. For up-to-date price information, check with your service representative, as listed in the *Appendix*, or contact the NLS home office.

PART NUMBER	DESCRIPTION	REQ. PER UNIT	SPARES REQ.
E1-155E	Capacitor, 1.5μf, 100 V, 10%	7	1
W20228	Capacitor, 0.1μf, 600 V, 20%	1	1
CM-15-E-680-F	Capacitor, 68 $\mu\mu$f, 500 V, $\pm$1%	3	3
CM-15-E-201-F	Capacitor, 200 $\mu\mu$f, 500 V, $\pm$1%	1	1
CM-20E-182-F	Capacitor, 1800 $\mu\mu$f, 500 V, $\pm$1%	1	1
CM-15C-050	Capacitor, 5$\mu\mu$f, 500 V, $\pm$0.5 $\mu\mu$f	1	1
VC5G	Capacitor, .8-18 $\mu\mu$f, 1000 V	2	2
D2-105	Capacitor, 1 μf, 200 V	1	1
PWE50020	Capacitor, 20 μf, 50 V	2	4
D2473E	Capacitor, .047 μf, 200 V	9	1
40B816	Capacitor, 40 μf, 450 V	1	2
30B306	Capacitor, 50 μf, 350 V	2	4
1B1248	Capacitor, 1000 μf, 10 V	1	2
1B1249	Capacitor, 250/250/250 μf, 50 V	1	2
D4-205D	Capacitor, 2 μf, 400 V	1	1
40B817	Capacitor, 10 μf, 450 V	1	2
MW64M4104	Capacitor, .1 μf, 400 V	2	1
XK2-682	Capacitor, .0068 μf, 200 V	1	1
1N429	Diode, Zener, 6 V	1	2
1N2071	Diode, Silicon, 600 V	24	50
1N916	Diode, Silicon, 75 V	2	4
LD-125	Diode, Germanium	19	50
STC-180	Diode, Silicon, 30 V	4	10
1N458	Diode, Silicon, 150 V	4	10
3/4 M14Z5	Diode, Zener, 14 V	1	2

RECOMMENDED SPARE PARTS LIST
(continued)

PART NUMBER	DESCRIPTION	REQ. PER UNIT	SPARES REQ.
313001	Fuse, 3AG, 1 Amp., Slo-Blo	1	10
312002	Fuse, 3AG, 2 Amp.	1	20
55ST-2-32	Lamp (Neon)	2	20
0369	Muffin Fan, Venturi	1	2
0250L-1	Potentiometer, 2KΩ	2	10
0250L-1	Potentiometer, 20KΩ	2	10
0250L-1	Potentiometer, 125KΩ	3	10
BR7Y1KC7	Relay, DPDT	3	10
RP7641-G8	Relay, DPDT, Type F	3	10
HGSS1001	Relay, Mercury	2	10
AW1635	Resistor, 2.2 Meg. ±0.1%, ⅔ W	4	4
PW1719	Resistor, 8 KΩ, ±0.1%, ½ W	1	1
PW1719	Resistor, 76KΩ, ±0.1%, ½ W	1	1
18035-109	Transformer, (Power)	1	2
9000-113	Transformer, (Pulse)	1	2
2N1310	Transistor, NPN	1	2
2N527	Transistor, PNP	4	10
2N651	Transistor, PNP	8	20
2N1305	Transistor, PNP	5	10
6201	Tube, Dual Triode	1	10
6AQ5A	Tube, Pentode	2	20
12AX7	Tube, Dual Triode	1	10
12BY7A	Tube, Pentode	1	10
6136	Tube, Pentode	2	20
5651	Tube, Regulator	1	20

PARTS LIST

This Section lists electrical parts used in the 125E. Hardware items such as brackets, grommets, nuts, and bolts have been deleted. If any unlisted item is required, contact the factory or your regional sales and service representative. Federal supply code numbers, as used in the last column of the listing, are drawn from the *Federal Supply Code for Manufacturers*, Cataloging Handbook H4-1. This publication may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C.

CIRCUIT REFERENCE	PART NUMBER	DESCRIPTION	QTY.	MFR.	FEDERAL SUPPLY CODE
	15004-076	Cable Assembly, AC-DC Converter to Series 20 or 30	1	NLS	03626
	15004-128	Cable Assembly, Output, Series 20	1	NLS	03626
	15004-129	Cable Assembly, Output, Series 30	1	NLS	03626
	18053-020	Basic Converter Assembly	1	NLS	03626
	0369	Muffin Fan, Venturi	1	Rotron	82877
	BR7Y1KC7	Relay, 1.8 to 18.0 V	1	Babcock	82050
	313001	Fuse, 3AG, 1 Amp. Slo-blo	1	Littelfuse	75915
	312002	Fuse, 3AG, 2 Amp.	1	Littelfuse	75915
	18053-109	Transformer, Power	1	NLS-Triad	81095
	18053-015	Range Board Assembly, Output	1	NLS	03626
C-9, C-28	EI-155E	Capacitor (Mylar Ext. Foil) 1.5 mfd, 100 V, 10%	2	Electron	99515
C-10	W20228	Capacitor (Mylar Ext. Foil) 0.1 mfd, 600 V. 20%	1	Westcap	96733
R-60, R-64, R-68, R-138	AW1635	Resistor, 2.2 Meg., ⅔ W, 0.1%	4	NLS	03626
R-63	PW1719	Resistor, 8KΩ, ½ W, 0.1%	1	NLS	03626
R-61	PW1719	Resistor, 76KΩ, ½ W, 0.1%	1	NLS	03626
K-2, K-3, K-4	RP7641-G8	Relay, DPDT, Type F, 675 ohms, 28 VDC, 3/16″ Leads	3	C. P. Clare	71482
R-5, R-6	0250L-1	Potentiometer, 2KΩ	2	Con-Elco	06184
R-7, R-8	0250L-1	Potentiometer, 20KΩ	2	Con-Elco	06184
R-2, R-3, R-4	0250L-1	Potentiometer, 125KΩ	3	Con-Elco	06184
	18051-018	Range Board Assembly, Input	1	NLS	03626
C-3, C-4, C-5	CM-15-E-680-F	Capacitor, 68$\mu\mu$f, 500 V, 1% (Silver Mica)	3	Arco	84171
C-6	CM-15-E-201-F	Capacitor, 200 $\mu\mu$f, 500 V, 1% (Silver Mica)	1	Arco	84171
C-7	CM-20E-182-F	Capacitor, 1800 $\mu\mu$f, 500 V, 1% (Silver Mica)	1	Arco	84171

PARTS LIST
(continued)

CIRCUIT REFERENCE	PART NUMBER	DESCRIPTION	QTY.	MFR.	FEDERAL SUPPLY CODE
R-9, R-10, R-137	MEFT-5	Resistor, 3 Meg., 1 W, 1% (metalized film)	3	IRC	75042
R-45	MEBT-5	Resistor, 900 KΩ, ¼ W, 1% (metalized film)	1	IRC	75042
R-62	MEBT-5	Resistor, 100 KΩ, ¼ W, 1% (metalized film)	1	IRC	75042
K-5, K-6	BR7Y1KC7	Relay, 1.8 to 18.0 V	2	Babcock	82050
R-11	GB1041	Resistor, 100 KΩ, 1 W, 10% (Comp)	1	AB	04061
C-8	CM-15C-050	Capacitor, 5$\mu\mu$f, 500 V, ±.5% (Silver Mica)	1	Arco	84171
C-1, C-2	VC5G	Capacitor, .8 to 18 $\mu\mu$f, 1000 V, (Rotary Trimmed)	2	JFD	73899
V-2	6201	Vacuum Tube, Dual Triode, 9 Pin	1	RCA	49671
V-3, V-4	6AQ5A	Vacuum Tube, Pentode, 7 Pin	2	RCA	49671
V-5	12AX7	Vacuum Tube, Dual Triode, 9 Pin	1	RCA	49671
V-6	12BY7A	Vacuum Tube, Pentode, 9 Pin	1	CBS	97966
V-7, V-8	6136	Vacuum Tube, Pentode, 7 Pin	2	RCA	49671
V-9	5651	Vacuum Tube, Gas Regulator	1	RCA	49671
T-2	9000-113	Transformer, Pulse	1	NLS	03626
V-1, V-10	55ST-2-32	Lamp, Neon, 55 V	2	Signalite	74276
K-7, K-8	HGSS1001	Relay, Mercury	2	C. P. Clare	71482
R-53	GB1041	Resistor, 100 KΩ, 1 Watt, 10%	1	AB	04061
R-12, R-117	GB6831	Resistor, 68 KΩ, 1 Watt, 10%	2	AB	04061
R-13	EB1235	Resistor, 12 KΩ, ½ Watt, 5%	1	AB	04061
R-14	EB1051	Resistor, 10 Meg., ½ Watt, 5%	1	AB	04061
R-17	EB2025	Resistor, 2 KΩ, ½ Watt, 5%	1	AB	04061
R-18, R-19, R-22, R-23, R-37, R-38	MEBT-5	Resistor, 100 KΩ, ¼ Watt, 1%	6	IRC	75042
R-20, R-21	MEBT-5	Resistor, 500 KΩ, ¼ Watt, 1%	2	IRC	75042
R-24, R-36	KC60	Resistor, 120 KΩ, ¼ Watt, 1%	2	KEY	05921
R-25, R-39	KC60	Resistor, 10 KΩ, ¼ Watt, 1%	2	KEY	05921
R-26	Brown Devil	Resistor, 500 Ω, 10 Watt, 5%	1	Ohmite	44655
R-27, R-28	EB2741	Resistor, 270 KΩ, ½ Watt, 10%	2	AB	04061
R-29	EB1001	Resistor, 10 Ω, ½ Watt, 5%	1	AB	04061
R-30, R-31, R-32	Brown Devil	Resistor, 10 Ω, 5 Watts, 5%	3	Ohmite	44655

PARTS LIST
(continued)

CIRCUIT REFERENCE	PART NUMBER	DESCRIPTION	QTY.	MFR.	FEDERAL SUPPLY CODE
R-33	EB6245	Resistor, 620 KΩ, ½ Watt, 5%	1	AB	04061
R-34	EB2241	Resistor, 220 KΩ, ½ Watt, 10%	1	AB	04061
R-35	EB1221	Resistor, 1.2 KΩ, ½ Watt, 10%	1	AB	04061
R-40	EB1051	Resistor, 1 Meg., ½ Watt, 10%	1	AB	04061
R-41, R-49, R-15, R-112	EB1021	Resistor, 1 KΩ, ½ Watt, 10%	4	AB	04061
R-42	Brown Devil	Resistor, 6 KΩ, 10 Watts, 5%	1	Ohmite	44655
R-43	HB2735	Resistor, 27 KΩ, 2 Watts, 5%	1	AB	04061
R-44, R-46, R-48, R-57	EB1011	Resistor, 100 Ω, ½ Watt, 10%	4	AB	04061
R-47	EB2251	Resistor, 2.2 Meg., ½ Watt, 5%	1	AB	04061
R-50	KC75	Resistor, 56 KΩ, 1 Watt, 1%	1	KEY	05921
R-51, R-54	KC75	Resistor, 43 KΩ, 1 Watt, 1%	2	KEY	05921
R-52	EB4745	Resistor, 470 KΩ, ½ Watt, 5%	1	AB	04061
R-96, R-98, R-127, R-128	GB2721	Resistor, 2.7 KΩ, 1 Watt, 10%	4	AB	04061
R-58, R-70, R-89, R-92	HB1521	Resistor, 1.5 KΩ, 2 Watts, 10%	4	AB	04061
R-94, R-72, R-73, R-91	EB1821	Resistor, 1.8 KΩ, ½ Watt, 10%	4	AB	04061
R-16, R-65	EB2231	Resistor, 22 KΩ, ½ Watt, 10%	2	AB	04061
R-67, R-84, R-130, R-99, R-100, R-107, R-131	EB2721	Resistor, 2.7 KΩ, ½ Watt, 10%	7	AB	04061
R-69	EB2211	Resistor, 470 Ω, ½ Watt, 10%	1	AB	04061
R-71, R-90, R-93	EB8211	Resistor, 820 Ω, ½ Watt, 10%	3	AB	04061
R-75, R-76	EB4731	Resistor, 47 KΩ, ½ Watt, 10%	2	AB	04061
R-77, R-78, R-79, R-82, R-85, R-86, R-105, R-108, R-109, R-74	EB3921	Resistor, 3.9 KΩ, ½ Watt, 10%	10	AB	04061

PARTS LIST
(continued)

CIRCUIT REFERENCE	PART NUMBER	DESCRIPTION	QTY.	MFR.	FEDERAL SUPPLY CODE
R-80, R-81, R-83, R-88, R-95, R-97, R-103, R-104, R-66, R-106, R-110, R-111, R-113, R-114, R-115, R-116, R-118, R-119, R-120, R-121, R-123, R-124, R-126, R-129, R-133, R-134, R-136, R-125, R-87	EB4721	Resistor, 4.7 KΩ, ½ Watt, 10%	29	AB	04061
R-101, R-102, R-132, R-135	EB1041	Resistor, 100 KΩ, ½ Watt, 10%	4	AB	04061
R-139	Brown Devil	Resistor, 400 Ω, 5 Watts, 5%	1	Ohmite	44655
C-33	D2-105	Capacitor, 1 mfd, 200 V	1	Electron	99515
C-13, C-15, C-16, C-19, C-27	E1-155E	Capacitor, 1.5 mfd, 100 V, 10% (Mylar Ext. Foil)	5	Electron	99515
C-11, C-14	PWE50020	Capacitor, 20 mfd, 50 V (Ceramic Cased)	2	Aerovox	97262
C-12, C-34, C-35, C-36, C-37, C-38, C-39, C-22, C-23	D2-473E	Capacitor, .047 mfd, 200 V, 10% (Mylar Ext. Foil)	9	Electron	99515
C-31	40B816	Capacitor, 40 mfd, 450 V Royalitic, P.C.)	1	Ind.Cond.Corp.	74861
C-17, C-18	30B306	Capacitor, 50 mfd, 350 V (Royalitic, P.C.)	2	Ind.Cond.Corp.	74861
C-20	1B1248	Capacitor, 1000 mfd, 10 V (Royalitic, P.C.)	1	Ind.Cond.Corp.	74861
C-21	1B1249	Capacitor, 250/250/250 mfd, 50 V (Royalitic, P.C.)	1	Ind.Cond.Corp.	74861
C-24	D4-205D	Capacitor, 2 mfd, 400 V	1	Electron	99515
C-25	40B817	Capacitor, 10 mfd, 450 V (Royalitic, P.C.)	1	Ind.Cond.Corp.	74861
C-26	E4-224E	Capacitor, .22 mfd, 400 V, 10%	1	Electron	99515
C-29, C-30	MW64M4104	Capacitor, .1 mfd, 400 V	2	Westcap	96733
C-32	XK2-682	Capacitor, .0068 mfd, 200 V	1	Electron	99515
CR-1	1N429	Diode, Zener, Silicon 6 V	1	Hoffman	28959

PARTS LIST
(continued)

REFERENCE CIRCUIT	PART NUMBER	DESCRIPTION	QTY.	MFR.	FEDERAL SUPPLY CODE
CR-2, CR-3, CR-4, CR-5, CR-6, CR-7, CR-8, CR-9, CR-10, CR-11, CR-12, CR-23, CR-24, CR-25, CR-32, CR-33, CR-34, CR-38, CR-39, CR-40, CR-46, CR-47, CR-15, CR-16	1N2071	Diode, Silicon, 600 PIV.	24	Texas Instruments	01295
CR-13, CR-14	1N916	Diode, Silicon, 75 V	2	Texas Instruments	01295
CR-21, CR-22, CR-26, CR-27, CR-28, CR-29, CR-30, CR-31, CR-35, CR-36, CR-37, CR-41, CR-43, CR-44, CR-45, CR-48, CR-49, CR-53, CR-54	LD-125	Diode, Gemanium	19	CBS	97966
CR-42, CR-52, CR-50, CR-51	STC-180	Diode, Silicon, 30 V	4	Silicon Tr. Corp.	07256
CR-17, CR-18, CR-19, CR-20	1N458 (HD6007)	Diode, Silicon, 150 V, PIV.	4	Hughes	73293
CR-55	¾ M14Z5	Diode, Zener, Silicon, 14 V	1	Motorola	04713
Q-1	2N1310	Transistor, Germanium, NPN	1	GT	04662
Q-2, Q-4, Q-5, Q-6	2N527	Transistor, Germanium, PNP	4	GE	03508
Q-7, Q-8, Q-9, Q-10, Q-11, Q-12, Q-13, Q-19	2N651	Transistor, Germanium, PNP	8	Motorola	04713
Q-15, Q-16, Q-17, Q-18, Q-3	2N1305	Transistor, Germanium, PNP	5	Texas Instruments	01295

PARTS LIST
(continued)

Model 125B

The Model 125B uses the parts listed on the preceding pages for the 125E except:

Delete

Resistors:
R-29, R-57, R-58, R-60, and R-64 through R-139.

Capacitors:
C-14, C-20, C-22, C-23, C-28, and C-32 through C-39.

Transformer:
T-2.

Relays:
K-2, K-7, and K-8.

Diodes:
CR-15, CR-16, CR-22 through CR-41, CR-43 through CR-49, CR-53, and CR-55.

Transistors:
Q-2 through Q-19.

Add

S-1, Switch, selector, 18069-009 NLS 03626

Model 125C

The Model 125C uses the same parts as the 125B except:

Delete

S-1, Switch, selector, 18069-009 NLS 03626

Add

K-2, relay.

APPENDIX

WARRANTY

Non-Linear Systems, Inc. warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this warranty is limited to servicing or adjusting any instrument returned, prepaid, to the factory for that purpose.

This warranty does not cover tubes, transistors, choppers, fuses, or batteries. However, non-oil-bathed stepping switches are guaranteed for 90 days provided they have been lubricated in accordance with manufacturer's instructions.

Instruments returned to the factory are accepted only when prior authorization has been given by an authorized representative of Non-Linear Systems, Inc.

Non-Linear Systems, Inc. reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of Non-Linear Systems, Inc. and Non-Linear Systems, Inc. neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Non-Linear Systems, Inc. instruments.

SHIPPING INSTRUCTIONS

Depending upon location, the choice of carrier will vary. Never ship an instrument to us without having received shipping instructions. If requested, an estimate of charges can be made before work begins.

Be certain to pack the instrument carefully; while an outer and inner box, separated by two or three inches of excelsior is desirable, the instrument can be placed into a single container provided it is so packed that it will not shift about. As with the double box method, use two or three inches of shock-absorbent packing materials. The instrument itself should be first wrapped in heavy paper so as to keep excelsior or other particles from entering the instrument's louvres.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it does not operate or is damaged, a claim should be made with the carrier. The claim agent should receive a full report of damage, and this report sent to Non-Linear Systems, Inc. After receiving such a report we will advise you of the disposition of the instrument and arrange for its repair or replacement. Be certain to include model and serial number when corresponding.

NON-LINEAR SYSTEMS, INC.
Del Mar, California

TECHNICAL INFORMATION BULLETIN

CALIBRATING AC DIGITAL VOLTMETERS

INTRODUCTION

The method that is generally accepted for calibrating the most precise AC voltmeters is a technique developed by F. L. Hermach at the National Bureau of Standards (see Reference). It is called the transfer thermocouple method, because the reading of accurate DC voltage measuring devices standardized against cadmium-mercury standard cells, is transferred to AC measurements. In this method of measuring AC voltage, the unknown AC is supplied to the heater of an instrument thermocouple, and the generated thermoelectric potential is measured by a millivoltmeter. The thermocouple heater is then connected to a DC power supply, and the voltage varied until the millivoltmeter reads the same thermoelectric potential as it did when the unknown AC was applied to the heater element. Absolute accuracy of the millivoltmeter is not important, but very fine resolution and repeatability are. The DC power supply voltage is then accurately measured and its value is, by definition, the true rms value of the AC voltage.

NLS PROCEDURE

All NLS AC-DC converters are calibrated against a Hermach-Engelhard Transfer Volt Ammeter. The NLS Hermach-Engelhard instrument has been certified by the National Bureau of Standards to plus or minus 0.05%. A variable turns ratio transformer accurate to plus or minus .001% is used to cover different ranges. Step by step instructions for calibration for specific models manufactured by NLS are included in each instrument's handbook.

EQUIPMENT USED

The calibration setup used at NLS is shown in Figure 1. The Hermach-Engelhard Transfer Volt Ammeter, which has ranges from 15 to 300 volts, is certified by NBS from 20 to 20,000 cps. The AC voltage source used for calibration must be stable enough to permit transferring the DC reading to AC without significant voltage output change. Also, harmonic distortion must be low, for the AC digital voltmeter reads in proportion to the waveform average value, but is normally calibrated in terms of the rms value of a pure sine wave. The power supply must cover the voltage and frequency range required with enough power to drive the thermocouple. NLS uses a special oscillator with a 0.05% maximum harmonic distortion, 0.01% short term drift, 6 watts maximum power output. 0.05% harmonic distortion produces much less than 0.1% error. An accurate attenuator is connected at AA in Figure 1 to extend the range. The Gertsch variable turns ratio transformer is used for this purpose and for checking that the AC digital voltmeter's 10, 100 and 1,000 volt scale multipliers are adjusted correctly.

SUBSTITUTED EQUIPMENT

If the customer desires to calibrate AC digital voltmeters but does not have Hermach-Englehard equipment, a Weston type V-I (insulated bead) instrument thermocouple and a millivoltmeter with high resolution and repeatability can be used. In the absence of thermocouple equipment, a precision laboratory AC voltmeter of the dynamometer type can be used for less accurate tests and over a restricted frequency range.

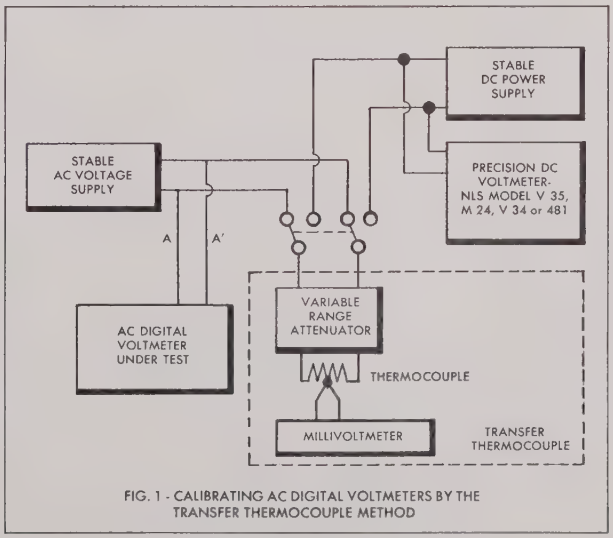
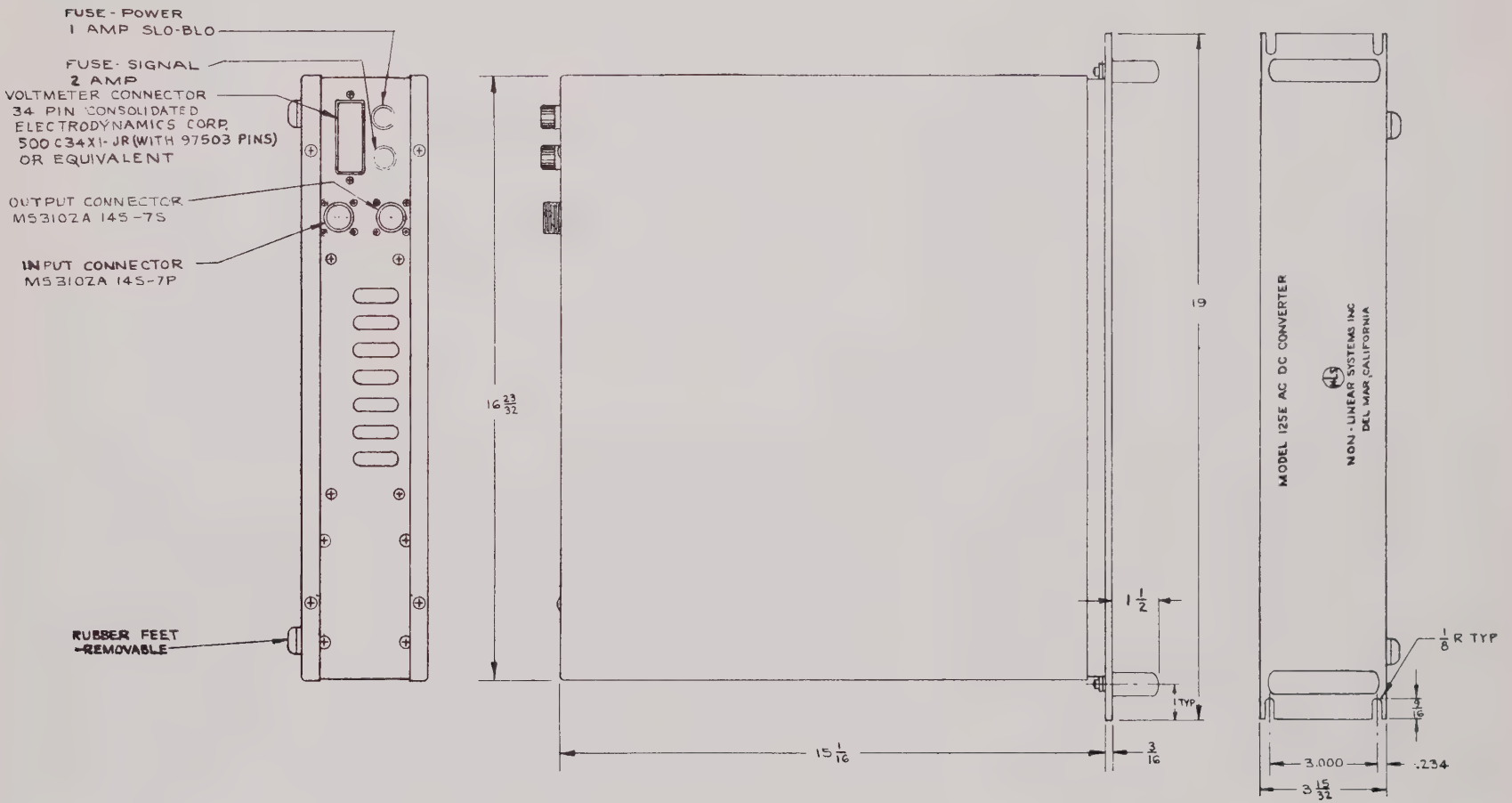
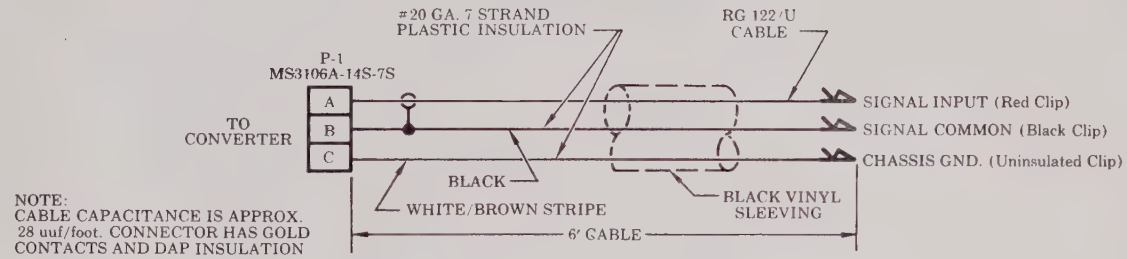


FIGURE 1

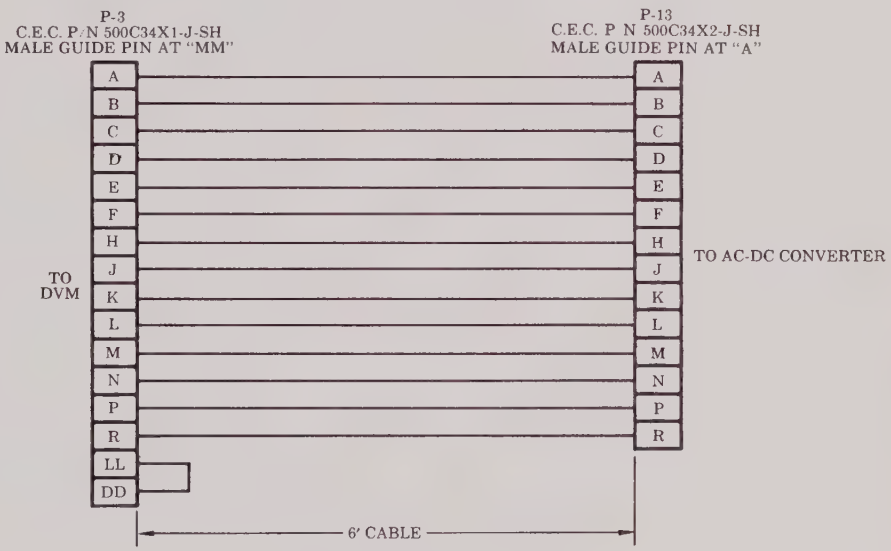
Calibrating AC Digital Voltmeters By The Transfer Thermocouple Method

References: Hermach & Williams - Multirange, A.F. Thermocouple Insts. Research Paper 2494 - U.S. Gov't Printing Office (bound in Vol. 52, Journal of Research, N.B.S.) - Hermach - Thermal Converters as Transfer Standards, Research Paper 2296 - U.S. Gov't Printing Office (bound in Vol. 48, Journal of Research, N.B.S.)

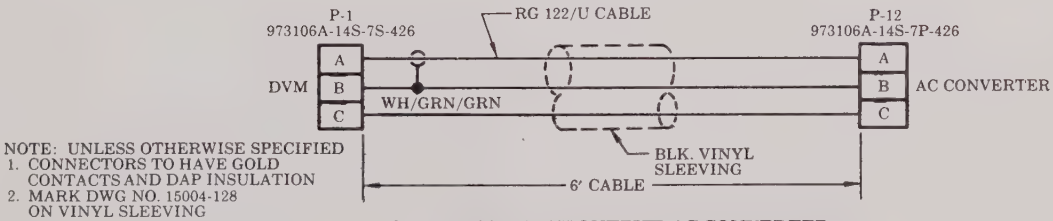

FUSE - POWER
1 AMP SLO-BLO
FUSE - SIGNAL
2 AMP
VOLTMETER CONNECTOR
34 PIN CONSOLIDATED
ELECTRODYNAMICS CORP.
500C34X1-JR(WITH 97503 PINS)
OR EQUIVALENT
OUTPUT CONNECTOR
MS3102A 14S-7S
INPUT CONNECTOR
MS3102A 14S-7P
RUBBER FEET
-REMOVABLE
16 23/32
19
1 1/2
1 TYP
15 1/16
3/16
MODEL 125E AC DC CONVERTER
NON-LINEAR SYSTEMS INC
DEL MAR, CALIFORNIA
1/8 R TYP
3/16
3.000
.234
3 15/32



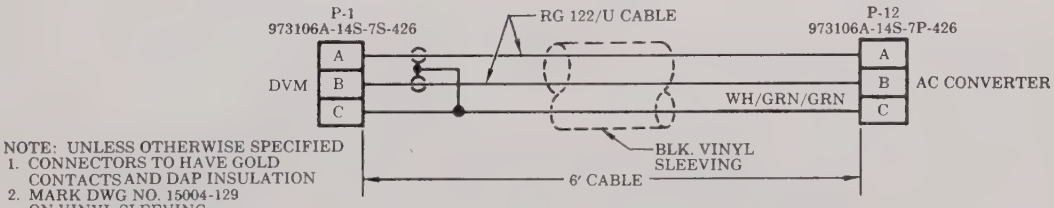
CABLE ASSEMBLY #15004-075



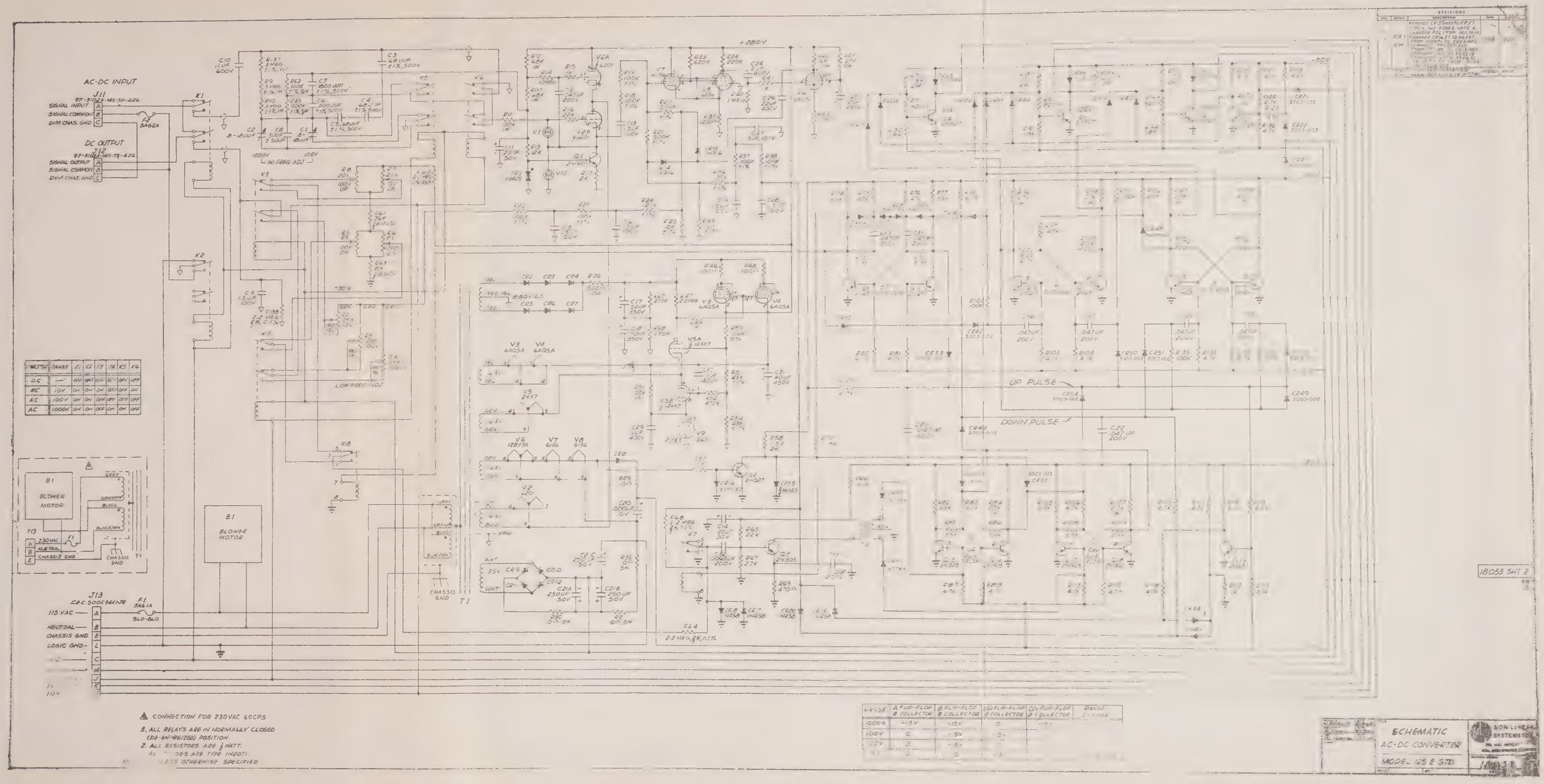
BELDEN #8748

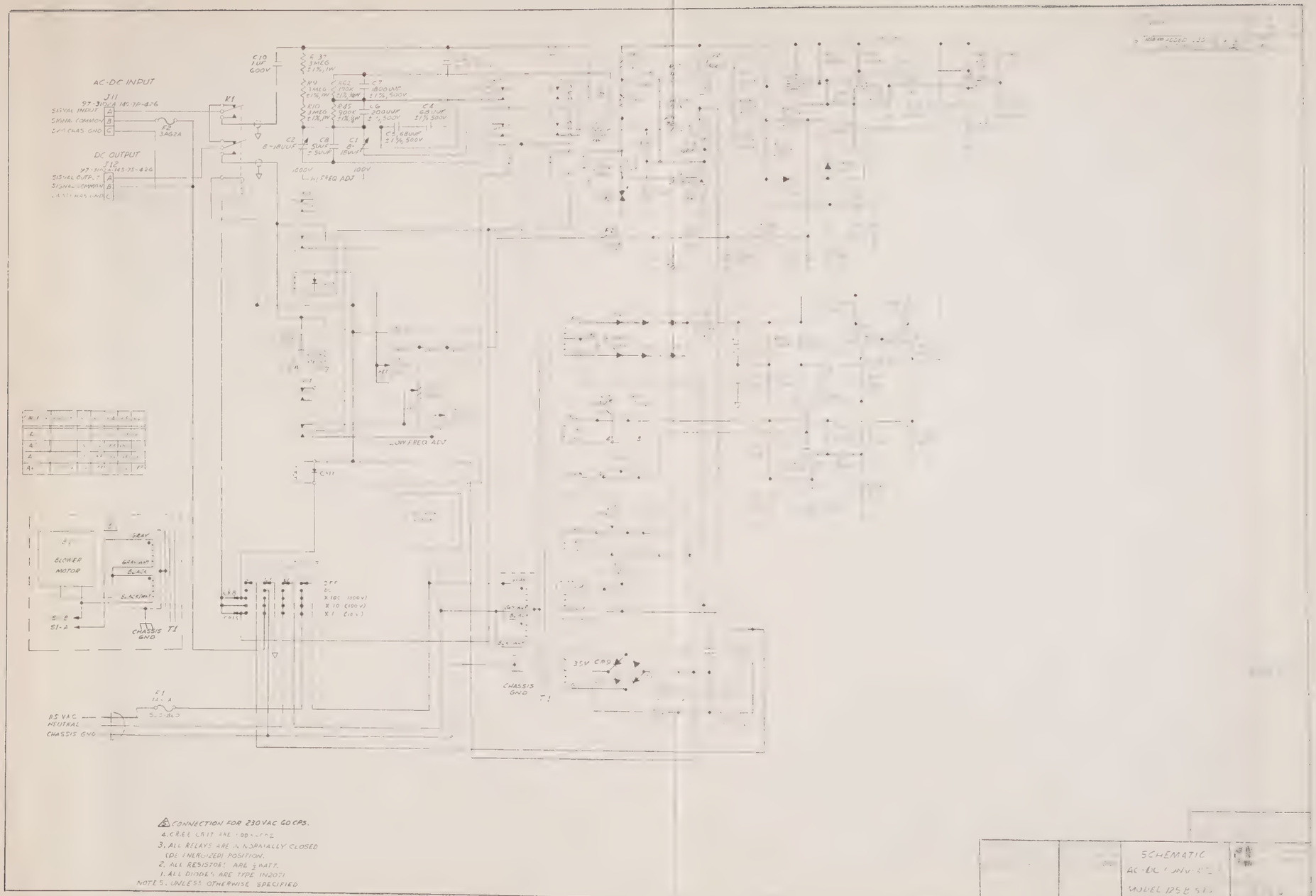


CABLE ASSEMBLY OUTPUT, AC CONVERTER
MODEL 125E TO SERIES 20 OR 40



CABLE ASSEMBLY OUTPUT AC CONVERTER
MODEL 125E TO SERIES 30


AC-DC INPUT
J11
97-31024-165-70-42G
SIGNAL INPUT
SIGNAL COMMON
DVM CHAS. GND
DC OUTPUT
J12
97-31024-165-72-42G
SIGNAL OUTPUT
SIGNAL COMMON
DVM CHAS. GND
+280V
-30V
HI FREQ ADJ
LOW FREQ ADJ
UP PULSE
DOWN PULSE
B1
BLOWER MOTOR
T13
230VAC
NEUTRAL
CHASSIS GND
T1
J13
115 VAC
NEUTRAL
CHASSIS GND
LOGIC GND-
+10V
-10V
CONNECTION FOR 230VAC 60CPS
3. ALL RELAYS ARE IN NORMALLY CLOSED (DE-ENERGIZED) POSITION.
2. ALL RESISTORS ARE ¼ WATT.
ALL DIODES ARE TYPE IN2071.
UNLESS OTHERWISE SPECIFIED
SCHEMATIC
AC-DC CONVERTER
MODEL 125 & 570
18053 SHT 2

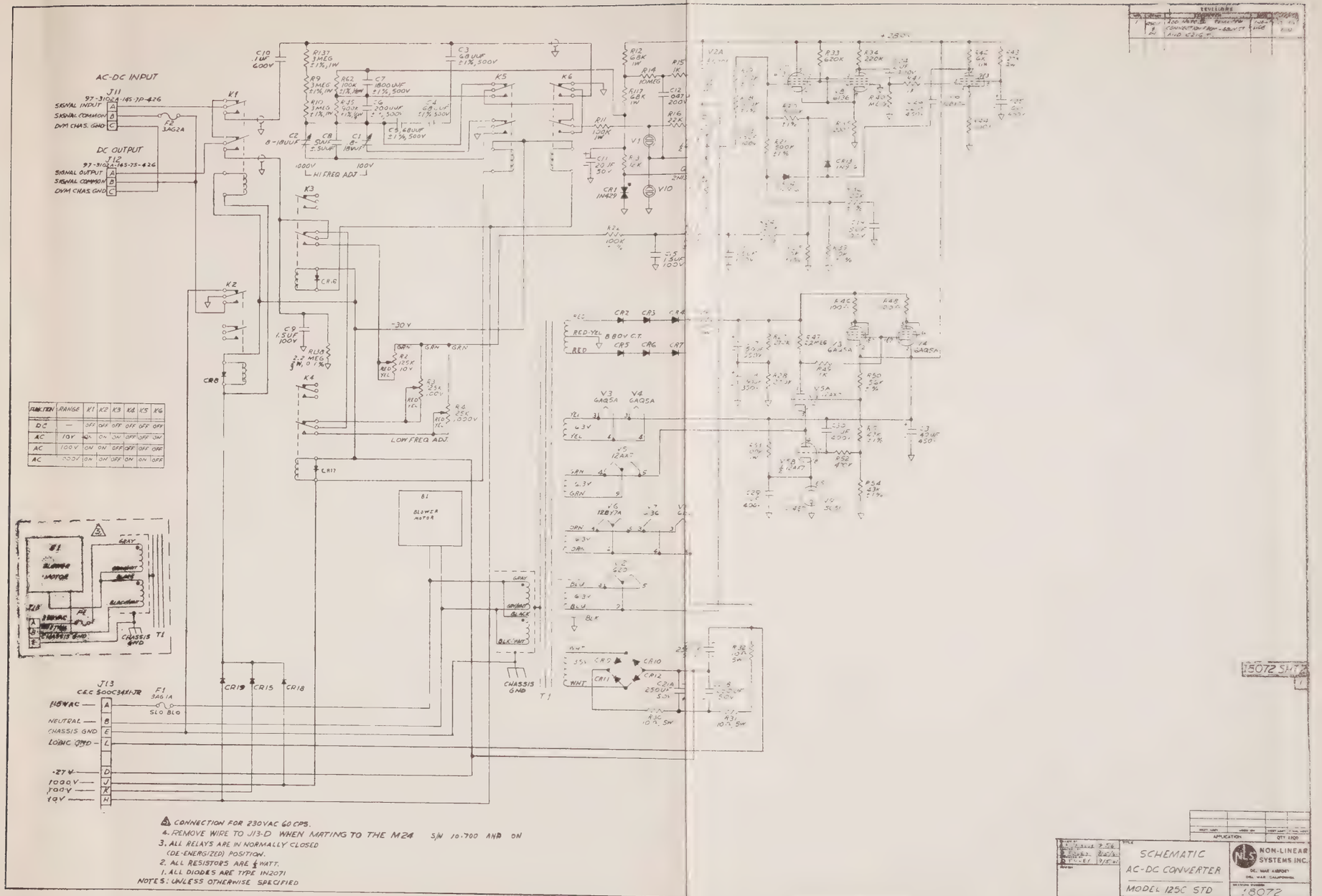


⚠ CONNECTION FOR 230 VAC 60 CPS.

4. CASE UNIT ARE 100-120 VAC.
3. ALL RELAYS ARE IN NORMALLY CLOSED (DE ENERGIZED) POSITION.
2. ALL RESISTORS ARE ½ WATT.
1. ALL DIODES ARE TYPE IN2071

NOTES: UNLESS OTHERWISE SPECIFIED

SCHEMATIC
AC-DC INVERTER
MODEL 125 B 51


AC-DC INPUT
J11
97-3102A-145-3P-426
SIGNAL INPUT
SIGNAL COMMON
DVM CHAS. GND
DC OUTPUT
J12
97-3102A-165-7S-426
SIGNAL OUTPUT
SIGNAL COMMON
DVM CHAS. GND
HI FREQ ADJ
LOW FREQ ADJ
-30 V
B1
BLOWER MOTOR
CHASSIS GND
J13
115 VAC
NEUTRAL
CHASSIS GND
LOGIC GND
-27 V
1000 V
100 V
10 V
FUNCTION
RANGE
K1
K2
K3
K4
K5
K6
DC
AC
10 V
100 V
1000 V
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL DIODES ARE TYPE IN2071
2. ALL RESISTORS ARE ½ WATT.
3. ALL RELAYS ARE IN NORMALLY CLOSED (DE-ENERGIZED) POSITION.
4. REMOVE WIRE TO J13-D WHEN MATING TO THE M24
S/N 10,700 AND ON
CONNECTION FOR 230VAC 60 CPS.
SCHEMATIC
AC-DC CONVERTER
MODEL 125C STD
NON-LINEAR SYSTEMS INC.
DEL MAR, CALIFORNIA
19072

INSTRUMENT SELECTION GUIDE

DATE OF ISSUE: MARCH, 1963

1952
11 Years of Progress in Digital Voltmeters
1963

World's Most Complete Line... By Purpose... By Price

- DIGITAL VOLTMETERS
- ACCESSORIES
- STANDARD SYSTEMS
- ENVIRONMENTAL TEST EQUIPMENT

Originator of the Digital Voltmeter
non-linear systems, inc.
DEL MAR, CALIFORNIA

EEM FILE SYSTEM: SECTIONS 2000, 2200, 2600, 2900

A Word on NLS...

Four facts graphically tell the story of the company that stands behind every NLS instrument or system.

1. Since originating the digital voltmeter in 1952, NLS has made more significant contributions to increasing the usefulness of the DVM and other digital measureing instruments and systems than any other firm. NLS "firsts" include "No-Needless-Nines" logic, first 4-digit ohmmeter, first 5-digit DVM, first 4-digit millivoltmeter, oil-bath stepping switches, first DVM with mercury-wetted contact relays, and dozens more.
2. NLS is the only major manufacturer specializing in digital voltmeters and associated instrumentation.
3. Published reports indicate that NLS is the acknowledged leader in brand preference.
4. Quality assurance is a way of life at NLS. For example, NLS no longer uses the assembly line process. Assembly teams of seven to 12 craftsmen build instruments by the batch method. Each individual craftsman is responsible for building an entire instrument, including preliminary testing upon completion. In addition to constant monitoring of quality, NLS conducts a continuing employee educational program in the belief that instrument quality must be built in rather than inspected in.

...And NLS Service

NLS is famous for service—with more service offices than any other DVM manufacturer. This comprehensive four-point servicing program is a major reason for the long-term success of NLS and for its extremely high percentage of repeat sales.

POINT 1—PREVENTIVE MAINTENANCE DESIGN. This phase of the program has two objectives: (1) to build reliability into instruments to keep malfunctions to a minimum, (2) to design them so that, when failures do occur as they eventually must in all things man-made, the user can locate the cause of the problem quickly and correct it easily.

POINT 2—PROMPT PARTS DELIVERY. All 19 NLS offices stock spare parts and plug-in modules, making parts service as close as your telephone.

POINT 3 – REPAIR SERVICE IN YOUR AREA. All offices are staffed with servicing experts who know NLS instruments intimately. The result: fast, friendly, more personalized service right in your area.

POINT 4—CUSTOMER TRAINING IN YOUR AREA. For customer convenience, courses on operation and servicing of instruments are conducted at NLS regional offices rather than the factory. There is no charge other than room and board, if required.

DIGITAL VOLTMETERS, DIGITAL RATIOMETERS, OHMMETERS

More than a decade of development on the digital voltmeter and associated instruments enables NLS to offer the world's most complete line of high-accuracy, high-quality digital measuring instruments. Breadth of the line, both by purpose and by price, permits you to select just the right instrument or group of instruments to meet your individual requirements — at the lowest price consistent with your needs.

To assist you in your selection, this "instrument selection guide" lists basic information on each standard model. *Blue color bands signify new products.* Please contact NLS or the nearest NLS office for complete information on models that interest you.

PRICES AND DELIVERY

Because all specifications and prices are subject to change without notice, NLS suggests you check with your NLS office for up-to-date information if considerable time has elapsed since publication of this issue of the "guide." Although NLS finds it necessary from time to time to increase prices, customers are often favorably surprised to be told of reduced prices on some models. When NLS is able to affect savings, they are passed along to customers in the form of lower prices.

Prices are FOB destination within U.S.A., except Hawaii and Alaska.

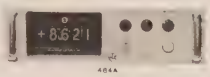
NLS instruments are generally available from stock, requiring five to 30 days delivery. A few specialized models require 30-60 days and systems generally require 30-90 days.

INPUT RESISTANCE

Input resistance of NLS digital voltmeters and ratiometers is generally 10 megs for voltage measurements, 1,000 megs for ratio measurements (10 megs on M25's two higher ranges). For Model 15 instruments: 625 ohms/volt; i.e., 62,500 ohms for a ±100-volt instrument. For Models 60, 60A, 60B, and 60C: 100 megs. V64B: 1,000 megs on low range, 10 megs on others.

FOR 50 CPS AND 220-VOLT OPERATION

Except digital clocks, all NLS instruments will operate on 50 cps power; Models 140 and 141 require a 50-cps chopper (no charge). Instruments with 220-v. taps on power transformers are the M25, M24, R24, V44, CH3, 784, 50, 51, 54, 54A, 54C, 55, 55A, S44, 190, 210, 261, 262, 180, 71, and all versions of the V34, V35, V60, R65, V91, V64, 484, and 125. On all other models, please consult NLS.

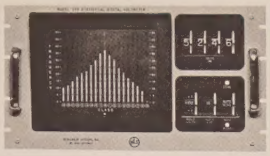
TO MEASURE	TYPE OF INSTRUMENT	MODEL	DIGITS	SPEED SEC. PER READING	RANGE-POLARITY CHANGING	RANGES	ACCURACY (rdg.= reading f.s. = full scale on range used)	TYPE OF DIGITAL OUTPUT	CONSTRUCTION	UNIQUE FEATURES	PRICE
VOLTS, RATIO AND OHMS		M25	5	1.1 Constant	Auto	±9.9999/99.999/999.99 v. ±.99999/9.9999/99.999 Ratio 9.9999/99.999/999.99 KΩ	±.01% of rdg. ±1 digit	Decimal Voltages	Transistors, Mercury Relays	Best combination of speed, accuracy, reliability, versatility	$5,985
		M24	4	.33 Constant	Auto	±.9999/9.999/99.99/999.9 v. ±.9999 DCV Ratio .9999/9.999/99.99/999.9 KΩ	±.01% of rdg. ±1 digit (.05% ±1 digit on Ω)	Decimal Voltages	Transistors, Mercury Relays	Best combination of speed, accuracy, reliability, versatility	$5,585
VOLTS AND RATIO		V35B	5	2.3 Maximum	Auto	±9.9999/99.999/999.99 v. ±99.999% DCV Ratio	±.01% of rdg. or ±1 digit ±0.005% on ratio	Decimal Contacts	Transistors, Oil-Bath Plug-In Stepping Switches	Fastest stepping switch DVM, high accuracy, unique logic	$3,985
		V35RB	5	2.3 Maximum	Auto	±9.9999/99.999/999.99 v. ±99.999% DCV Ratio	±.01% of rdg. or ±1 digit ±0.005% on ratio	Decimal Voltages	Transistors, Reed Relays	Versatile, accurate reed-relay DVM, unique logic	$3,785
		V35RBC	5	2.3 Maximum	Auto	±.9999/9.999/99.99/999.9 v. ±99.999% DCV Ratio	±.01% of rdg. or ±1 digit ±0.005% on ratio	Decimal Contacts	Transistors, Reed Relays	Versatile, accurate reed-relay DVM, unique logic	$4,185
		V34B	4	1.9 Maximum	Auto	±.9999/9.999/99.99/999.9 v. ±99.99% DCV Ratio	±.01% of rdg. ±1 digit	Decimal Contacts	Transistors, Oil-Bath Plug-In Stepping Switches	Fastest stepping switch DVM, unique logic	$3,585
		484A	4	1 Average	Auto	±9.999/99.99/999.9 v. ±99.99% DCV Ratio	±.01% of rdg. ±1 digit	Decimal Voltages	Plug-In Stepping Switches, Vacuum Tubes	Low cost, highly accurate, versatile	$1,460
VOLTS		15	4	67 x 10⁻⁶ Constant	Auto Polarity	±.9999 or ±9.999 or ±99.99 v. One range only (specify)	±.01% of f.s. ±1 digit	B-C-D Volts. B-C-D Readout	All-Electronic	Extremely fast, accurate and reliable	$4,985
		15B	4	67 x 10⁻⁶ Constant	Auto Polarity	±.9999 or ±9.999 or ±99.99 v. One range only (specify)	±.01% of f.s. ±1 digit	Binary Volts and Readout	All-Electronic	Extremely fast, accurate and reliable	$4,985
		15C	4	67 x 10⁻⁶ Constant	Auto Polarity	±.9999 or ±9.999 or ±99.99 v. One range only (specify)	±.01% of f.s. ±1 digit	Decimal and B-C-D Volts. Dec. Readout	All-Electronic	Extremely fast, accurate and reliable	$5,485
		V44	4	0.005 Constant	Auto Polarity	±9.999/99.99/999.9 v.	±.01% of f.s. ±1 digit	Decimal and B-C-D Volts	All-Electronic	Fast, very reliable	$6,185
		V91	4	0.01 in any one range	Auto	±9.999/99.99/999.9 v.	±.01% of f.s. ±1 digit	None	All-Electronic	Lowest priced 4-digit all-electronic DVM	$2,585
		V91P	4	0.01 in any one range	Auto	±9.999/99.99/999.9 v.	±.01% of f.s. ±1 digit	Decimal Voltages	All-Electronic	Lowest priced 4-digit all-electronic DVM	$2,985
		V64B	4	0.75 Average	Manual	±9.999 v., Use 641 Divider ($175) for ±99.99/999.9 v.	±.01% of rdg. ±1 digit	None	Plug-In Stepping Switches, Vacuum Tubes	Lowest cost, high accuracy	$885
		RV2 Battery operated	4	0.25 Avg. 0.4 Max.	Auto	±9.999/99.99/999.9 v.	±.01% of f.s. ±1 digit	None	Transistors, Reed Relays	Battery operated, fast, reliable, low cost, complete grd. isolation	$2,185
VARYING VOLTAGES, PEAK VOLTAGES		CH3	4	0.013 Approx.	Auto Polarity	±9.999/99.99/999.9 v.	±.01% of f.s. ±1 digit. Lower for peaks	Decimal and B-C-D Volts	All-Electronic	Highest accuracy and versatility for dynamic measurements	$6,185
VOLTAGE RATIO		R65A	5	1.5 Average	Auto Polarity	±99.999% DCV Ratio	±.01% of rdg. ±1 digit	None	Plug-In Stepping Switches, Vacuum Tubes	Low cost, high accuracy	$2,135
		R65B	5	1.5 Average	Auto Polarity	±99.999% DCV Ratio	±.01% of rdg. ±1 digit	Decimal Voltages	Plug-In Stepping Switches, Vacuum Tubes	Low cost, high accuracy	$2,335
MILLIVOLTS AND MILLIOHMS		V60	4	1.5 Average	Manual Polarity	±99.99 Millivolts	±.1% of rdg. ±1 digit	None	Plug-In Stepping Switches, Vacuum Tubes	Low cost, high precision, good common mode rejection	$1,660
		V60A	4	1.5 Average	Manual Polarity	±99.99 Millivolts	±.1% of rdg. ±1 digit	Decimal Voltages	Plug-In Stepping Switches, Vacuum Tubes	Low cost, high precision, good common mode rejection	$1,960
		V60B	4	1.5 Average	Auto Polarity	±99.99 Millivolts	±.1% of rdg. ±1 digit	None	Plug-In Stepping Switches, Vacuum Tubes	Low cost, high precision, good common mode rejection	$1,960
		V60C	4	1.5 Average	Auto Polarity	±99.99 Millivolts	±.1% of rdg. ±1 digit	Decimal Voltages	Plug-In Stepping Switches, Vacuum Tubes	Low cost, high precision, good common mode rejection	$2,160
		24173	4	1.5 Average	Manual	±99.99 Millivolts 9.999/99.99/999.9/9999 Ω	±.12% of rdg. or ±1 digit	On special order	Plug-In Stepping Switches, Vacuum Tubes	Internal safety circuits for pyrotechnic testing, 4-terminal input	$2,785
OHMS AND OHMS DEVIATION		784	4	1 Average	Auto Ranging	.9999/9.999/99.99/ 999.9/9999 KΩ	±0.05% of rdg. ±1 digit, ±0.1% above 5 megs	Decimal Voltages	Plug-In Stepping Switches, Vacuum Tubes	Low cost, high accuracy	$1,460
		DO24	4	.33 Avg. .17 Special	Auto Polarity	±99.99% deviation from 100Ω to 1 meg. Below 100Ω special	±1 digit to 100 KΩ ±10 digits at 1 meg.	Decimal Voltages	Transistors, Mercury Relays	Fast, accurate, reliable, covers full ±99.99% range	$5,685

STATISTICAL DIGITAL VOLTMETERS

DESCRIPTION	PRICE
With a push of a button, these instruments provide an accurate, statistical description of a test, experiment or production run. Wherever data must be evaluated in statistical form, the SV2 and SV3 automatically classify input voltages and display results as a bar graph (frequency distribution histogram). With suitable transducers, they'll classify lengths, pressures, temperatures, resistors, etc. SV2 accepts up to 3 entries per sec., classifies and stores them, and within 30 sec. after command, completes plotting a 22-class histogram on chart paper. SV3 with speed of 5 entries per sec. presents 19-class histograms on a visual display which can be examined, photographed or traced prior to being cleared to zero after use. Accuracy of each: approx. ±0.01%.	SV2: $9,385 SV3: $7,385

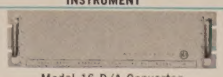
MODELS

SV2



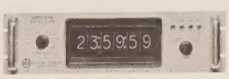
SV3

OTHER STANDARD INSTRUMENTS

PURPOSE	INSTRUMENT	DESCRIPTION	PRICE
Digital To Analog Conversion	 Model 16 D/A Converter	Makes 250,000 conversions/sec. Range: ±9999 input; ±10 v. output. Will drive a 500Ω load at full accuracy of ±0.001 v. Model 16 is B-C-D; 16B straight binary.	16: $3,085 16B: $3,085
Binary To Decimal Conversion	S44 Converter	Converts pure binary numbers to visual decimal number display. 6,000 eleven-bit conversions/sec. Other versions available.	$4,035
Digital Telemetering	190/210 Telemeter	Requires only 4-wire cable (plus gnd.) to display DVM readings 1 mile away. Error-free even with considerable noise or line reactances. Speed for 4-digit number (±9999) is 36 ms.	$3,750
Low-Cost Data Logging With Printer	RS2 Data Logger	Scans 20 double-pole inputs . . . measures ±0.001 to ±999.9 VDC and DC ratio to ±99.99% . . . ±0.01% ±1 digit accuracy . . . records 4-digit measurement with polarity, range and channel ident. Speed of scan-measure-print cycle is 1.2 sec./channel, avg. RS2 has DVM — RS2/S does not.	RS2: $3,635 RS2/S: $2,385
Low-Cost Data Logging With Tape Punch	RS3 Data Logger	Scans 20 double-pole input channels, connects them to a DVM (not supplied), and provides punched tape record. Any 5, 6, 7, or 8 channel code. Word capacity: 33 digits. Has built-in serial converter.	$2,685
Automating Mass Spectrometer Data	MSD2 Digitizer	Automatically records mass spectrometer ion voltage peaks and associated acceleration voltages. Also useful for highly accurate measurement of voltage peaks in other uses. Features high reliability, mass number resolution of ±0.2 under worst conditions, speed of 4 peaks/sec., and elimination of noise and spurious peak problems.	$24,885
Automatic Go/No-Go Testing	51 Comparison Amplifier	Compares an input voltage to either 1 or 2 external limit voltages. Transistorized. Range is ±50 v.; to 100 v. if limit-to-input difference is 25 v. Sensitivity: 500 μv. Comparison time: 90 ms.	$985

INPUT AND OUTPUT ACCESSORIES

INPUT ACCESSORIES

TYPE OF INSTRUMENT:	DESCRIPTION	MODEL	PRICE
PREAMPLIFIERS 144	General purpose, differential AC-DC amplifier with isolated gnd, and isolated input. Gain: x1/3/10/30/100/300/1,000 plus a vernier. Bandwidth: 0-10KC. Full scale output: ±10 v. Linearity: ±0.01%. Stability: ±0.01% Gain acc.: ±.01%. Drift: .5μv/°C max. Settling time: 200 μsec. to .01%. Recovers within .05% amplitude from 5x overload in 200 μsec. Input resistance: 100 megs. Common mode rejection: 120 db @ 60 cps @ 1,000 ohms unbalance. 150 db @ DC.	144	$985
143	General purpose, differential DC amplifier with isolated ground and isolated input. Gain: 10/100/1,000, manual or remote selection. Linearity: ±.01%. Stability: ±.04%. Input resistance: 1 meg. Rated max. input and output: ±10 v. Common mode rejection: 160 db @ DC, 120 db @ 60 cps.	143	$1,185
	Increases input resistance of Model 15 A/D Converter to 50 megs, min. Full scale input: ±10 v. Gain: x1. Accuracy: ±.01% of 10 v. Settles to ±.01% within 4 μsec. even after 200% overload. Not gnd. isolated.	142	$785
	Extends range of DVMs with resolution of 100 μv. per digit to ±99.99 mv. full scale. Gain: x10. Min. input resistance: 10 megs. Not gnd. isolated.	141	$985
140	Extends range of DVMs with resolution of 1 mv. per digit to ±99.99/999.9 mv. Gain: x10/100. Input resistance: 10 megs. Not gnd. isolated.	140	$985
INPUT SCANNERS 261	Sequentially scans up to 200 single-pole channels. Visual and electrical channel identification. Transistorized-stepping switch type, gold-plated contacts, versatile control modes.	261	$2,535
	Similar to Model 261 except has 100 double-pole capacity.	262	$2,535
	Similar to 261 in many ways but uses crossbar switch. Available for 1,200 or 600 one-wire, 300 two-wire, 200 three-wire, or 100 six-wire inputs.	Crossbar	$4,035-$5,985
SAMPLE AND HOLD MODULE IDS2	Permits Model 15 A/D Converter to sample and accurately measure rapidly varying voltages at a specific point in time. Gain: x1 (others on special order). Input and output range: ±10 v. Gain accuracy: ±.01%. Gain stability and linearity: ±.01% of f.s. Input impedance: 10 megs min. Max. settling time from +10 v. to −10 v.: 9 μsec. Disconnect time: .25 μsec. Hold aperture: .5 μsec.	IDS2	$2,500
DIGITAL CLOCKS  DC6B1	These transistorized, resettable clocks display elapsed time in 6 numerals, provide data for recording, and issue various timing pulses. Standard ranges: 99 hr, 59 min, 59 sec for DC6A1 and DC6B1; 23 hr, 59 min, 59 sec for DC6A2 and DC6B2. Other ranges available. DC6B1 and DC6B2 are rack-mount; DC6A1 and DC6A2 fit into NLS 155 Printer.	DC6A1	$1,285
		DC6B1	$1,285
		DC6A2	$1,285
		DC6B2	$1,285
AC/DC CONVERTERS 225	Use 225 with NLS DVMs for ultra-accurate AC measurement. Conversion accuracy from 50 cps—10 KC up to 9.9999 v. is ±(.01% of rdg. +.001% of f.s.) plus accuracy of standard used for calibrating the 225. Accuracy decreases at higher frequencies. Consult NLS regarding higher voltage ranges. Input impedance: 1 meg shunted by 20μμf. Settling time: 3 sec. max. within a range.	225	$1,985

TYPE OF INSTRUMENT:	DESCRIPTION	MODEL	PRICE
AC/DC CONVERTERS 125B 125E	Plug into NLS DVMs for AC voltage measurement. All are average value sensing. Ranges: 9.999/99.99/999.9 v. Frequency: 30 cps—10 KC. Input impedance: 10 megs shunted by 100μμf. Accuracy: ±(.1% of rdg. +1 mv. at output). Settling time: 3 sec. avg., 8 sec. max. within a range. 125B has front panel range switch; 125C uses DVM switch; 125E has auto ranging. Add 125ER to 125B or 125C to measure AC voltage ratio (consult NLS).	125B	$1,235
		125C	$1,235
		125E	$1,235
		125ER	$1,685

OUTPUT ACCESSORIES

TYPE OF INSTRUMENT:	DESCRIPTION	MODEL	PRICE
PRINTERS 155	Transistorized, parallel entry, 11-column printer specially engineered for use with NLS DVMs. Prints 9 numeral col. (one for decimal point placement code) and 2 symbol col. for polarity and other data (volts, ratio, AC, etc.). Colons available. Prints in .2 sec. Special commutators and brushes increase reliability. Many formats available.	155	$1,510
TYPEWRITER AND FLEXOWRITER SYSTEMS 	Each system consists of IBM Electric Typewriter or SFD Friden Flexowriter plus NLS Serial Converter (264 for typewriter, 264F for Flexowriter). Flexowriter punches 8-channel tape and can operate from its built-in tape reader (coding must be specified completely). Carriage widths from 12" to 30"; e.g., Model F12 for 12" Flexowriter, T30 for 30" Typewriter. Speed: 8 characters/sec, nominal.	F12	$6,332
		F16	$6,435
		F20	$6,470
		T12	$4,120
		T16	$4,162
		T20	$4,203
		T24	$4,258
		T30	$4,396
SERIAL CONVERTERS 264	Transistorized units to convert the time parallel data from DVMs into time serial form needed for typewriters, Flexowriters and tape punches. 264 output is in decimal form; 264F in binary coded decimal. Max. capacity: 31 characters per word, 22 different letters. Specify coding and format.	264	$2,535
		264F	$2,535
TAPE AND CARD PUNCHES Tally 420	Operates from 264F Serial Converter at 60 characters/sec. Uses .687", .875" or 1.00" tape, 5, 6, 7 or 8 channels. Consult NLS regarding higher speeds.	Tally 420	$1,415
	Depending upon their input requirements, some card punches can be operated by NLS DVMs, 180 Output Adapter.	Card Punches	Consult Punch Mfr.
OUTPUT ADAPTERS 180	Inverts DVM printer-output polarity to operate HP 561B Printer.	71	$635
	Converts DVM print output voltages into time parallel contact closures in decimal system for operating Clary 703 and some card punches and other equipment requiring contact closures.	180	$1,535
DIGITAL COMPARATORS 54 54A	Connect to any NLS DVM with print connection for indication and printing of high-limit or low-limit tolerance conditions or for control and warning purposes. Operates with any combination of polarity and ranges. Limits of 54 and 55 are remotely set by voltages or contact closures in parallel 8-4-2-1 form; 54A, 54C and 55A also settable by front panel dials. 54 and 54A are for 4-digit DVMs; 55 and 55A for 5-digit DVMs; 54C for 784 Ohmmeter. 0.01 sec. comparison time. Transistorized.	54	$2,035
		54A	$2,435
		54C	$2,435
		55	$2,535
		55A	$2,935

STANDARD SYSTEMS

The most versatile of the hundreds of digital measuring and recording systems custom-built by NLS in the past 11 years are now being offered as standard systems rather than custom systems. These selected systems which fill the application needs of many tasks in science and industry provide all the advantages of standard systems, including: • Increased reliability that comes only from refinements resulting from actual on-the-job operation. • Easier, faster maintenance because of field experience and more ready availability of parts. • Lower costs than custom-built systems. Their wide variety of capabilities include the following (not included in any one system, of course): • Automatic scanning, up to hundreds of input channels. • Measurement of a wide range of AC and DC voltages, voltage ratios, resistances, and resistance deviations. • Four- or five-digit measurement with accuracies up to ±(0.01% +1 digit). • Speeds from one channel per second to thousands of channels per second. • Recording by data printers, tape or card punches or magnetic tape recorders. • Digital comparison for go/no-go tests for warnings or recording

only measurements which are outside pre-set limits. • Temperature measurements using thermocouples and built-in thermocouple reference junctions. • Fast change-over of system recording formats or programming via patch panels.

ENVIRONMENTAL TEST EQUIPMENT

DELTA DESIGN

All products manufactured by Delta Design, Inc., are now marketed and serviced by the 19 offices of Non-Linear Systems, Inc.

TEMPERATURE CHAMBERS

1060B Chamber with MR-1 Sequencer and BC-2 Cabinet

1060X-1

1060W

Wide range of standard models from 0.14 to 5.8 cu. ft. from —200°F to 600°F, and with control to ±¼°F. Depending upon model, will cool to —65°F in 1½ to 8 min. and heat to 500°F in 6 to 35 min. (From 70°F). Sides, rear or front of Model 1060X-1 are easily cut to accommodate long items (e.g., waveguides, laboratory glassware) or for installing over floor-mounted equipment (e.g., centrifuges, vibration tables, motors).

GENERAL INFORMATION ON CHAMBERS: line voltage 115v., 60 cps (Model 1060B: 220v., 60 cps) . . . centrifugal blowers for air circulation . . . aluminum cabinet with stainless steel interior . . . most models use metered injection of liquid CO_2 for cooling, some use either liquid CO_2 or dry ice. $545 to $1,675

DRAWERS AND DOORS
Several types to replace standard chamber door to facilitate handling and testing. Some provide holes for electrical connection to chamber contents. $55 to $185

6WG

TEST FIXTURES
Specially designed for reliable electrical connection and switching when testing transistors, diodes and other components. Wide range of models for many types of testing. $310 to $1,480

TTT-60WD

SOLID-STATE CONTROLLERS
Reliably control temperatures of chambers or processes from —100°F to 600°F with 0.1°F sensitivity. Higher temperatures on special order. Unique Delta temperature anticipator prevents overshoots and is 10 times more stable against heat load variations and ambient changes than other controllers. $450 to $690

Probes from $35 to $75

Model CRP

TEMPERATURE MONITORS
Prevent temperature excursions beyond set limits and indicate temperatures . . . —100°F to +600°F range. Higher temperatures on special order. Control span as small as 20°F. Both bench and rack models. $200

TM-1R

AUTOMATIC PROGRAMMERS

MR-1

MR-2

MR-3

MR-1 Time Sequencer automatically cycles chambers between any high and low temperature (intervals adjustable) for thermal shock testing, etc. MR-2 Programmer cycles chambers from any low to ambient to any high to ambient, as in MIL-STD 202B tests (intervals adjustable). MR-3 Rate Programmer controls the rate of change of chamber temperature (solid-state temp. controller also required at added cost). Programming set by an easily changed plastic cam. AM-3 Rate Reducer decreases cam speed. AM-4 Variable Hold Time Module stops cam at preset point (interval adjustable).
MR-1: $380 MR-2: $835 MR-3: $480

COMPLETE TEST SYSTEMS
Combination of Delta and NLS instrumentation provides complete systems from one reliable source.

OTHER EQUIPMENT
Other Delta equipment is described in the booklet "ENVIRONMENTAL CONTROL EQUIPMENT FOR RESEARCH AND INDUSTRY." Ask for a copy.

A NEW SOURCE OF INFORMATION ON DIGITAL MEASUREMENT . . .

The NLS customer-oriented approach to management extends also to its advertising program which seeks to keep you informed on the latest significant information on digital measurement. The major portion of the program consists of editorial-type ads appearing in electronics trade publications and other technical magazines such as SCIENTIFIC AMERICAN. Each ad presents an interesting measuring problem and shows how it was actually solved through digital techniques.

Periodically, other NLS ads will keep you informed on new NLS instruments and systems and their applications.

19 FACTORY OFFICES TO SERVE YOU

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NLS Bldg., 1015 Fremont Ave.
South Pasadena, Calif.
Murray 2-3705 Area Code 213

AREA 2B
NLS Southwest District Office
8000 Fletcher Pkwy., La Mesa, Calif.
465-4141 Area Code 714

AREA 2C
NLS Southwest District Office
415 Cambridge St., Palo Alto, Calif.
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1439 N. First St., Suite 102
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253-1221 Area Code 602

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FEderal 7-4315 Area Code 202

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HAzel 8-1663 Area Code 609

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TUxedo 9-1277 Area Code 312

AREA 9B
NLS Northcentral District Office
3300 S. Dixie Drive, Dayton 39, Ohio
298-8638 Area Code 513
TWX 513-944-0128

AREA 10
NLS Southeast Regional Office
Federal 7-4315 Area Code 202

AREA 11A
NLS Southeast Regional Office
1925 "K" St., N.W., Washington 6, D.C.
FEderal 7-4315 Area Code 202

AREA 11B
NLS Southeast District Office
1500 King's Highway, Cherry Hill, N. J.
HAzel 8-1663 Area Code 609

AREA 11C
NLS Southeast District Office
705 W. Colonial Dr., Orlando, Florida
423-8901 Area Code 305

AREA 11D
NLS Southeast District Office
3224 Peachtree Rd., N.E.
Atlanta 5, Georgia
233-1375 Area Code 404

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NLS Northeast Regional Office
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516-333-7020 TWX 516-333-8548

AREA 12B
NLS Northeast District Office
Fairfield Office Center
387 Passaic Ave., Caldwell, N.J.
228-2525 Area Code 201

AREA 12C
NLS Southeast District Office
235 Bear Hill Road, Waltham, Mass.
TWin Oaks 9-1430 Area Code 617

AREA 12D
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Syracuse 11, N.Y.
454-9304 Area Code 315

AREA 12E Canada
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St. Laurent, Quebec, Can.
514-747-4781

Aeromotive Engin. Products, Ltd.
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RU 3-4288

AREA 15 Export
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981-5262 Area Code 415

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